Strawberry Valley Project
Wasatch and Utah Counties
Utah

HAER No. UT-26

HAER
UTAH,
25-PAYS
1-

PHOTOGRAPHS
WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Rocky Mountain Region National Park Service
Department of Interior
Denver, Colorado 80225

I. INTRODUCTION

NAME

Strawberry Valley Project, HAER No. UT-26

DESCRIPTION OF STRUCTURES

The Strawberry Valley Project, a Federal water development project, is divided into three major components: a collection system. a storage system, and a distribution system.

The collection system diverts the waters of the Strawberry River, Indian Creek, Trail Hollow Creek, Horse Creek, and Currant Creek into a storage reservoir. A small earth dike across Trail Hollow Creek diverts the Creek through the Trail Hollow Intake Structure into a four-mile canal which empties into a small catchbasin created by the Indian Creek Crossing Diversion Dam. The Indian Creek Crossing Diversion Dam channels the waters of Indian Creek and Trail Hollow Creek through the Indian Creek Intake Structure into a two-mile canal. In route to the reservoir, Indian Creek Canal picks up the water of Horse Creek, and empties all the collected water through the "terminal chute" into the Strawberry Reservoir. To measure the amount of water developed by the collection system, there is a notched weir at the top of the terminal chute. The collection system just described was built during the original construction period. The only addition to this system has been the Currant Creek Feeder Canal, built in 1934-35 as a Civilian Conservation Corp Project.

The Strawberry Reservoir is formed by a dam across a narrow canyon of the Strawberry River and a dike built across the low area between Strawberry Valley and Indian Creek Valley. The reservoir covers 8,400 acres and contains a maximum of 283,000 acre-feet of water.

The 3.8 mile Strawberry Tunnel empties the stored reservoir water into the natural channel of Sixth Water Creek, then into Diamond Fork Creek, from which it flows into the Spanish Fork River. Just before the River leaves Spanish Fork Canyon, a portion of the water is diverted through the Spanish Fork Diversion Dam into the 3.3 mile Power Canal. At the end of the Power Canal is another diversion structure, which divides the Canal flow in two, with one half going into a penstock and down to the Spanish Fork Powerhouse, and the other half going into the High Line Canal for irrigation in southern Utah Valley. The High Line Canal is the major distribution feature of the Project. It follows the contour of the foothills for 17.5 miles, trending generally to the south and west. Water is distributed by 58 miles of concrete-lined laterals to Project farmers. A second canal, the Springville/Mapleton Lateral, draws water from the Power Canal, carries it northward through a siphon across the Spanish Fork River, to irrigate farms on the Mapleton Bench.

The Strawberry Valley Project also has three, small hydroelectric facilities: the Spanish Fork Powerhouse, the Lower Spanish Fork Power Plant, and the Payson Power Plant.

LOCATION

Trail Hollow Intake Structure, Trail Hollow Canal, Indian Creek Diversion Dam, Indian Creek Canal, and Strawberry Reservoir are generally located in Range 11 West, Townships 3 and 4 South, Salt Lake Meridian. Irrigated project lands are located in Ranges 2 and 3 East, Township 8 South; and Ranges 1 and 2 East, Township 9 South.

LIST OF PROJECT FEATURES AND CONSTRUCTION COMPLETION DATES

HAER No. UT-26

Strawberry Dam: dam completed 29 October 1912 and dam spillway completed 20 September 1913
Indian Creek Dike: 10 October 1912
Strawberry Tunnel: 13 December 1912
Trail Hollow Intake Structure: 30 September 1912
Trail Hollow Canal: 5 November 1912
Indian Creek Crossing Diversion Dam and Intake Structure: 5 November 1912
Indian Creek Canal: 20 September 1912
Bridges over Indian Creek Canal: August 1912
Indian Creek Terminal Chute & Weir: 20 September 1912
Diamond Fork Canyon Construction Road and Bridges: 1906-07
Spanish Fork River Diversion Structure for Power, High Line, and Springville/Mapleton canals: 13 December 1908
Power Canal: 13 December 1980
Springville/Mapleton Lateral: October 1918
Spanish Fork Powerhouse and Diversion Structure: 13 December 1908
Lower Spanish Fork Power Plant: 1937
High Line Canal: 1 December 1916
Lateral 20, High Line Canal: 1 December 1916
Lateral 30, High Line Canal: 1 December 1916
Lateral 31, High Line Canal: June 1917
Lateral 32, High Line Canal: June 1917
Lateral 34, High Line Canal: June 1917
Payson Power Plant: 1941

ENGINEERS

Original Project Surveys: Frank C. Kelsey, Halen & Halen, George Swendsen
Supervising Engineers: L. C. Hill
Project Engineers: James Lytel
George Swendsen

HISTORICAL SIGNIFICANCE

As the first project built by the U.S. Reclamation Service in Utah, the Strawberry Valley Project had a major impact on the State. It represents the beginning of Federal assistance in water development, development on which the rest of the State's economy depends. The Project had a major impact on the way water is developed and distributed in Utah, by heralding the era of large storage dams and distribution systems. In addition, the application of the National Reclamation Act of 1902 eventually modified Utah's legal and institutional mechanisms for controlling water development. The significance of the Strawberry Valley Project is discussed in greater detail in Chapter XIII.

II. WATER DEVELOPMENT IN UTAH, 1847-1903

The U.S. Reclamation Service's authorization of the Strawberry Valley Project on December 15, 1905 marked the beginning of a new stage in the development of Utah's water resources. Throughout the 19th century, settlers had streamed through the mountain passes into Utah--Mormon pioneers gathering to "Zion," cattlemen looking for new and untapped ranges, and immigrants from Southern and Eastern Europe lured by the promise of jobs in Utah's railroads, mines, and smelters. The State's population grew from 12,000 in 1850 to 275,000 in 1900, (an annual growth of 6.3 percent, or a doubling rate of 12 years) and by 1910, another 100,000 people would arrive (Thomas 1920:16). The foundation of this rapid growth was an agricultural economy--18,000 small farms, irrigated by a lacework of canals snaking their way from jagged mountain canyons across the gently rolling bench and bottomland of Utah's valleys.

By the turn-of-the-century, however, water development had slowed to a crawl. Almost all of the irrigation projects that were feasible for the cooperative labor of small communities, or the financial resources of private corporations had been undertaken. Almost all of the yearly flow of Utah's streams in the populous Wasatch Front Valleys had been "appropriated" as well. The value of the land and the crops produced simply could not finance the massive water storage projects that were needed to save enough water for the dry, late-summer growing season. Those farmers who had rights to only the spring runoff could barely make a living in the best of economic conditions, and in the bad years many of them failed and left the land. Either something had to alter the weather, or someone had to change the economics of water development.

At this juncture, the Federal Government entered the picture with the passage of the Federal Reclamation Act on June 17, 1902 which authorized the expenditure of public moneys in 16 Western States for the construction of large irrigation projects, with repayment schedules that could be born by the farmers living "under the project."

F. H. Newell, first Director of the Reclamation Service, interpreted Article 9 of the Reclamation Act to mean that each one of the 16 States included in the law should immediately receive a project--a move that also helped solidify the Service's political base, because each State would immediately derive some benefit. Five projects were authorized by the end of 1903; North Platte in Wyoming and Nebraska, Milk River in Montana, Truckee-Carson in Nevada, Uncompahgre in Colorado, and the Salt River Project in Arizona. By the spring of 1905, 11 of the 16 States had a Federal Reclamation project, and that autumn, the Service made a concerted effort to have projects initiated in the remaining five States. The December 15, 1905 authorization of the

Strawberry Valley Project makes it the last of the original 16 projects initiated by the Reclamation Service (Newell 1906).

By the time construction began on the Strawberry Valley Project, irrigated agriculture in Utah was a half-century old. Mormon pioneers had come to the "Valley of the Great Salt Lake" seeking a place isolated enough from the rest of America that they could practice their religious beliefs without interference. Nearly 1,000 miles from the nearest settlement of any size, these pilgrims from the humid farmlands of the Eastern States were forced to develop water to provide for the full range of basic necessities, including agriculture that produced a variety of crops, power for milling, and water for culinary use.

Some historians have claimed that Utah was the "first" to begin irrigation in Western North America, but the Native Americans of the Southwest, and later the Spanish moving northward into California, Arizona, and New Mexico built small ditches and diverted water for their crops (Thomas 1920:11). The importance of Utah's experience with irrigation is the scale on which it took place. Within 20 years of the first settlement, 85,000 people depended primarily on irrigation for their daily bread. By 1870, Utah had developed her own new methods for developing and distributing water, and created a new set of social institutions and laws governing the use of water that were vastly different from those in the humid Eastern States. The experience of these early settlers is an interesting example of how human institutions adapt to the demands of a new environment.

The key environmental fact of the Mormon's new home was the limited availability of water. Later, systematic studies by the United States Geological Survey (Powell 1879) showed that only about 4 percent of Utah's land area is suitable for intensive, irrigated agriculture, primarily because of the impossibility of getting water to it. Much of the water that was available in the early settlement areas of the State was limited to a few streams descending from the Wasatch Mountains that run north and south in the central portion of the State. The first settlers were aware, however, that although the climate was arid, the land was fertile. Orson Pratt, a member of the advance party into Salt Lake Valley in July 1847, recorded this observation in his diary:

> Streams from the mountains and springs were abundant, the water excellent, and generally with gravel bottoms, a great variety of green grass, and very luxuriant, covered the bottoms for miles where the soil was sufficiently damp, but in other places the soil was good, yet the grass had nearly dried up for want of moisture (Pratt 1847).

On the first day in the Valley, the advance party selected a spot near what is now City Creek in Salt Lake City, plowed the land, planted potatoes, and dammed the creek, sending its water over the field and giving it "a good soaking."

Utah's new legal and social institutions governing water development were shaped by a unique culture as well. Most settlement in other parts of the West was by individuals seeking their fortunes in ranching, mining, or the railroads. These settlers were an independent breed, and the communities they created were often as short-lived as the available grass, or the easily extracted ore. Many came only with a suit of clothes, a horse, and a desire to make money enough to take home with them. The Mormon settlers came as a group and for entirely different reasons. They viewed their Great Basin settlements as the long-term foundation for the survival of their religion. The Mormons came with a strong feeling of community, a cooperative tradition, and a belief that their Church leaders were "divinely inspired" and ultimately had the final word in all secular and religious matters.

This cooperative religious culture, coupled with a lack of capital, poor transportation, and few tools, made Utah's early canals crude community undertakings. Generally, the religious leader of the community would organize a committee of farmers to plan and construct an irrigation system. "In the construction of an irrigation system, the bishop played a leading part in getting the people together so that they could elect a committee to take actual control of the work." George Thomas wrote, in describing the early construction efforts, "The bishop himself was frequently a member of the managing committee" (Thomas 1920:14). Members of the committee then laid out the route of the canal, laterals, and ditches to individual farms. Without capital to hire laborers, the committee usually chose a simple route that was feasible for the number of individuals available for construction work. Each farmer was given a share of the water according to the amount of labor he had provided in construction, which was proportional to the amount of land he had to water. Later when more settlers had arrived, other canals were built that took their water out further upstream from the original canal and typically watered the higher bench areas. By 1900, the older, more settled valleys of the Wasatch Front had a network of parallel canals stretching out from either side of major streams.

In laying out canals, the services of a surveyor were generally available only in the more settled communities. Sometimes the farmers simply filled a pan with water and sighted over the edges along the proposed route, or filled a bottle with water and set it on the square edge of a board to form a crude spirit level (Thomas 1920:21). Naturally, these efforts did not always result in the optimum grade, and early canals often had areas where the water ran quickly and then settled into turbid pools.

Most canals were built primarily with picks and shovels and a simple tool called a "go devil." The go devil was two planks braced in the shape of an "A," dragged by a yoke of oxen along the route of the canal. Any soil that remained was shoveled out and tamped down into a bank to hold the water (Thomas 1920:24). Areas where a canal crossed a ravine or gully

were filled by wagon loads of earth and allowed to settle for a couple of years before they were firm enough to hold water.

Laterals constructed in the same fashion carried water from the main community canal to groups of farmers, who dug individual ditches to guide the water to their fields. Headgates and sidegates on the main canal were generally built of wood embedded into the bank, but by the time the water reached an individual ditch, the farmer would direct the flow onto his fields simply by cutting a hole in the side of the ditch with a shovel and filling it in when he was finished.

Once a canal was completed, the day-to-day management was usually turned over to a "watermaster," and a cooperative canal company was formed. The watermaster had several duties:

(1) To see that water was kept in the canal.

(2) To prevent the canal from breaking and to call out the farmers to help repair it when it did.

(3) To notify an irrigator when it was his "turn" to use the water flowing in the canal.

(4) To prepare an annual report to the canal company.

(5) To manage the annual maintenance work, usually done each spring (Thomas 1920:25).

The canal companies were "corporations" with a unique organization. Farmers who had contributed labor to the canal construction were considered "shareholders," and held "shares" in the canal company, but these shares did not pay dividends, as did shares of a private corporation. They represented "shares" of the water in the canal equal to the amount of labor invested, which was determined by the amount of water a farmer would need to irrigate, and no charge was thus made for the water delivered. Each irrigator was assessed a yearly maintenance fee (which also paid the watermaster's salary) according to the number of shares he had. Water shares could be sold or rented, and the water used on any land that could be reached by the canal. In Irrigation Institutions, Elwood Mead relates the effect this peculiar form of "corporation" had on the capitalists of that era.

> Under this plan, shares of stock in a ditch are looked upon and treated as shares in the water which fills the ditch. The financial results are sometimes perplexing to stockholders, as one example will show. The farmers who began the D & W Canal were not able to complete it. To raise money for this purpose they sold some stock to a banker not familiar with irrigation methods. When the canal was completed, the banker was assessed on his stock to help pay running expenses. He received no dividends because there was no charge for water, and

> hence no revenue from the canal. His stock entitled him to a part of the water of the canal, but he had no land on which to use it. He could not sell it to the farmers, because they were able to take his share along with their own. For several years, he was assessed on his stock to help pay the running expenses of the ditch from which he derived no revenue whatever. This could not continue forever, and the investment was too large to be sacrificed. The stock at the time had no selling value, and unless some change could be made in the method of operating the ditch, the investment would prove a total loss. The method taken to improve the situation was as ingenious as it was successful. He loaned his stock to one of the farmers under the ditch for a single year. This farmer was the envy of all his neighbors; he had water whenever he needed it in unlimited abundance. The next year other farmers wished to share in their neighbor's opulence. When the banker refused to lend his stock, they agreed to rent it. In a few years, it was renting for enough to pay interest, and subsequently was sold for enough to repay the investment (Mead, 1903:236).

In a capital short, labor rich society like early Utah, this form of business institution was an effective method of adapting social institutions to the demands of irrigated agriculture. Farm size was kept small, averaging about 30 acres, because a farmer could have only as much water as the amount of labor he could donate to the building of a canal. The 160-acre size of farm given to homesteaders under the Federal Homestead Act was far too large for a single farmer to water unless he had enough money to hire laborers. Few settlers in early Utah had this much money, so they "clubbed together" as Elwood Mead noted (1903:235), in a cooperative construction effort. Since there was always a serious shortage of hard cash in the Territory, it would have been difficult to charge cash for water and distribute "dividends" on canal company stock. Water was all the return on his labor investment that the farmer really wanted.

The fact that irrigated agriculture was more capital intensive than humid zone agriculture was realized only slowly in the 19th century.

> There is encountered at the outset a difference between agriculture by irrigation and agriculture by rainfall, which is radical in its nature. We have been accustomed to regard agriculture as a non-capitalized industry, and much loose talk has been indulged in about farmers creating homes in the arid West by their unaided efforts as they formerly did on the prairies of Illinois and Iowa. Those who attempt this find scenery and mountain air a poor support while building flumes and digging ditches. This misconception of the preliminary outlay required has caused much serious hardship to individuals and has stood in the way of

> enacting proper laws. Everyone recognizes the need of capital and organization in the building of railroads. There is no one who does not appreciate the necessity for money in starting a factory, and who would not recognize the absurdity of a hod-carrier trying, without aid, to erect a six-story block; yet they insist that the equally costly and more difficult construction which must precede the watering of arid lands, can be carried to completion by home-seekers, without either money, organization, or technical acquaintance with the problems to be solved (Mead 1903:19).

The Mormons solved these problems by cooperatively building a plethora of smaller canals and keeping farm size to manageable proportions. Later, Bureau of Reclamation engineers would criticize these numerous canals as not the most efficient way to utilize the available water. Many small, poorly built canals lose far more water from seepage and evaporation, than one large cement-lined system designed to distribute all the water from a particular source. The larger system, nevertheless, would have required more capital than was available, better engineering, and a longer lead time before crops could be planted--conditins which would have doomed the early settlements. Once the institution of the partnership or cooperative canal took root in Utah, it remained the dominant form until well into the 20th century. In 1900, partnership and cooperative canals watered 91.1 percent of the irrigated farmland in Utah (Thomas 1920:19).

During the first 3 years of settlement (1847-50), there was no formal, secular government in Utah. Brigham Young, President of the Mormon Church, directed the affairs of the settlers. Young, along with other Church leaders, set up communities, distributed land (Peterson 1982:12), doled out limited Church funds for projects, and generally managed the economic affairs of the Territory (Arrington 1958), including the allocation of water. From this experience, the pioneers generally came to recognize "public" or community ownership of basic resources, such as water. A farmer was granted only the "right" to use water. This right was further restricted by allowing use so long as water was not wasted and it was put to a use that benefited the community. In many ways, the success of these settlements also meant the success of the religion, and this fostered a cooperative spirit about the prudent use of the most vital resource.

Inevitably, there were disputes over water rights. Devices for measuring water flow were primitive and inaccurate. As more settlers arrived, many streams had all of their average low-water flow appropriated, and newcomers were only able to use the spring runoff. It would be difficult for anyone to stand by and watch his hard work wither during a drought, if his neighbor's fields were still green because he had first right to the lessened flow. The authority of the

local official (called a "bishop") to make decisions and settle disputes about water use was almost universally accepted (Mead 1903:232; Thomas 1920:84; Avery and Singer 1982:7). When an early Utah farmer felt that someone was infringing on his "right," he would make a complaint to the bishop, who would then call the disputants to a hearing, listen to the evidence, perhaps visit the canals or ditches in question, and make a decision. This proceeding had more the character of an administrative hearing, than a formal legal process. There were no lawyers, no extensive taking of testimony from expert witnesses, and the bishop was generally well informed himself as to the existing water rights in the community.

On September 9, 1850, President Millard Fillmore signed a law which made Utah an official U.S. Territory, and established a Territorial Government. In its first session on February 4, 1852, the Territorial Legislature passed an act creating county courts (which functioned primarily as a county commission and not a court), composed of a probate judge and three selectmen, and gave them control of water resources:

> The County Court has the control of all timber, water privileges on any water course, or creek to grant mill sites, and exercise such power as in their judgement shall best preserve the timber and subserve the interest of the settlements in their distribution of water for irrigation or other purposes. All grants or rights held under legislative authority shall not be interfered with.

Without having specifically said so in any legislative act, and without having received the authority in the Territorial Act signed by President Fillmore, the Legislature codified the custom of the Territory by assuming that timber and water "privileges" were owned by the community and theirs to grant. Subsequently, the Legislature made large grants of water to various canal companies, including the Provo Canal and Irrigation Company (1853) which was given half the water in the Provo River; the Cottonwood Canal Company (1855) which was given half the water in Cottonwood Creek; and "Aaron Johnson and others whom they may associate with them, authority to take one third of the waters from the warm stream of Spanish Fork City and convey same in the best possible route to a tract of land known as Springville survey, and contract the same for irrigation purposes" (Thomas 1920:50).

Although in 1852, the county courts officially assumed control of water rights and of the settling of water disputes, most of the ensuing grants of rights were settled by the Mormon Church (Mead 1903:232; Avery and Singer 1982:8). During the early years of settlement, before there was any real non-Mormon presence in the Territory, the county courts and the local leaders of the Mormon Church were often the same individuals. There was a unique unity of church and state in Utah, and the county courts

were often used to put a secular stamp of approval on what was really a decision of ecclesiastical authority. In 1855, for instance, the Davis County Court acknowledged this de facto relationship by granting "that the bishops of the several wards of Davis County shall have the right and power to control the water powers of the canyons, and etc., so far as it shall be deemed for the general welfare of the public" (Thomas 1920:84).

In 1865, the Territorial Legislature passed the Utah Irrigation District Act, which set up a formal governmental mechanism for raising funds to pay for large irrigation systems. The actual working of the Act tended to resemble the existing method for organizing and building irrigation systems, where a farm village, or a number of villages, planned and constructed the system cooperatively. The only virtue of the Irrigation District Act was, as Elwood Mead noted, "a district had no advantages over an ordinary incorporation of those interested, except that a few people could be forced into the district organization against their wills" (Mead 1903:234).

A district could be organized by calling a mass meeting to elect district trustees, a secretary and treasurer, and then decide whether the district would levy a tax on only the lands benefited or on all the land within the proposed boundaries. Afterwards, the trustees conducted the necessary surveys and made estimates of the time and cost involved, and the whole plan was then voted on in a special election. A two-thirds vote established the district. The Irrigation District Act did not, however, give districts the right to sell bonds. All construction moneys had to be raised by a direct tax. Immediately after passage, a number of districts were organized in Salt Lake County, but elsewhere in the State the law was little used (Thomas 1920:121).

Until the law was repealed in 1897, there were only minor changes to the Utah Irrigation District Act. An 1878 amendment changed the public notice rules for levying the tax and restricted the tax levies to only the farmland irrigated by the system--meaning that not all the land within the boundaries of a district was taxed to pay for the works. In 1884, the Legislature increased the penalties for delinquent taxes, giving the district trustees the right to halt an individual's use of water and prevent him from voting or holding public office. It was a Utah Supreme Court decision, Harris vs. Tarbet, that effectively killed the District Act by overturning the 1878 amendment requiring the trustees to limit the area taxed to only those receiving water (Thomas 1920:125). Some irrigation districts had been drawn to include large areas of grazing land, which would now have to pay taxes equal to the irrigated cropland. This form of taxation would have put an unbearable burden on many farmers who raised small numbers of livestock on nearby grasslands, and most of the districts were quickly disorganized. Irrigation works built under the Act were then typically organized into cooperative canal companies (Thomas 1920:125).

As the 19th century drew to a close, and relations between Mormon and non-Mormon, and Mormons and the Federal Government grew more acrimonius, Church members were frequently admonished to avoid the secular courts (now more often run by non-Mormon Federal appointees) in water disputes, a rationale expressed by Bishop McCullough in an 1878 meeting of the Utah County Stake of the Mormon Church:

> We should do all we could to avoid going to Law over disputes on the water question (Utah Stake Historical Record Book 64904, July 6, 1878).

At the same meeting, Bishop John E. Booth supported McCullough's position, and reflected the views of Utah County Church leaders in his comments:

> The settlement of water difficulties (should be by) the judgment of the Priesthood, as the courts were not thoroughly versed in the justice of the cases relating to water as were the old settlers of the County (Utah Stake Historical Record Book 64904, July 6, 1878).

It was widely recognized among Mormon Church leaders that control of Utah's water resources meant control of the State's economy as well, and the threat of a hostile Territorial Government run by anti-Mormon Federal appointees moved the Church to change the entire structure of Utah's water laws.

In 1880, the Territorial Legislature passed an act declaring that water was no longer publicly owned and transferred ownership to those then holding a use right. After 1880, water appropriated for a beneficial use became the property of the appropriator. With the abandonment of public ownership, water shares could be traded like any other piece of property. It had been the custom of the Territory as well to fix the place of use for the water right, and that usually meant water was appurtenant to the land and not divisible from it. The 1880 law also changed this practice. The only role left the County Courts under this new scheme, was to adjudicate disputes, a role later rescinded when the legal community objected that settling disputes over private property was the role of the judiciary (Thomas 1920:55).

One important, lasting advance in water law made by the 1880 Act was the definition of classes of water rights, based on the length of use, amount of water available, and the establishment of a method whereby in drought years, the lower volume of water could be equitably divided. R. P. Teele describes this system:

> All rights to the use of a stream acquired up to the time that the sum of the rights is equal to the ordinary low-water flow of the stream are primary rights, and seven years undisturbed use gives a primary right. Those acquiring rights to water after the low-water flow is exhausted, or who use water during high water, have secondary rights. In times of scarcity,

> holders of secondary rights receive no water, and whatever water a stream furnishes is divided among the holders of primary rights pro rata, according to their respective rights, and these rights are sometimes based on the area irrigated and sometimes on a ratio fixed by the court which defined the rights to that stream. There is no general rule. The law carries the classification no further than the two classes, but some of the subsequent court decisions carried the same principle further and divided the rights to a single stream into a large number of classes. In such cases the first class receives what water it needs, if there is enough water the second class takes what it needs, and so on until a class is reached for which there is not enough water. All classes below this get no water, and what water is not needed by higher classes is divided pro rata among the holders of rights in the class in which there is a shortage. The division of rights into classes is peculiar to Utah and is a wise compromise between the absolute "priority" theory enforced in some states, under which the first comer takes the full volume of water to which he is entitled, regardless of the needs of his neighbors, and the utter disregard of priority, advocated by some, under which the lands of the early settler can be robbed of their value by compelling him to divide his water supply with an ever-increasing number of irrigators (Teele 1903:24).

The 1880 law gave the job of recording all these water rights to the county courts, making them ex-officio water commissioners. When the arbitration role of the county courts was questioned, the process of ajudicating and recording rights came to a halt, and there was no central source to which a prospective irrigator could go to determine if all the rights of a particular stream were appropriated. Furthermore, there was now no one to prevent a latecomer from diverting an existing water right into a new canal. The only recourse for a farmer whose water was being diverted upstream was to argue his case before a district court judge. The lack of any enforcement power in respect to water rights often had disastrous results:

> In 1901, the rights to the Jordan River were adjudicated in a proceeding which lasted the longest time and is said to have cost the most money of any lawsuit ever waged in the State of Utah. Almost immediately after the adjudication, two new claims were filed, and if the work is carried out it will compel all the parties who have been to such great expense in defending their rights to begin again this legal fight for existence (Mead 1903:226).

Later historians and activists in the movement for Federal participation in water development viewed the 1880 law as a real

step backward in Utah's progress toward the equitable distribution of water:

> The question naturally arises, why this radical change in the Law? It can be explained only by the fact that serious difficulties were arising between the citizens of Utah and the Federal Government. All the executive officers of the Territory had long since been appointed from non-residents. Threats were made that Congress would take the franchise away and either appoint all the officials both local and general in the Territory or leave them to the election of the non-Mormons, very few of whom were interested in agriculture. The most natural thing, therefore, was to repeal the authority exercised by the county courts, declare the water rights vested, and leave them, if difficulties arose, to the courts (Thomas 1920:56).

Other historians dispute Thomas' view of the reason water was given over to private ownership in 1880. They see the end of community ownership as part of a more general movement in Utah during that period away from the cooperative economy.

> The 1880 law did not benefit only the Mormon Church, but anyone appropriating water for any use, including mining and manufacturing companies. The 1880 law was evidence of the demise of the cooperative commonwealth characteristic of early Utah and the subsequent movement to a more capitalistic economy (Alexander 1982).

Elwood Mead, Director of Irrigation Investigations for the Department of Agriculture and later, Director of the U.S. Reclamation Service, saw in Utah's 1852 Statute the ideal attributes of a system of water law, and lamented that the "State has gone backward since 1852." In speaking of the early Mormon system, Mead said:

> We have here, then, at the very beginning of irrigation development in this country, the recognition of public ownership, the granting of rights by an executive board which was familiar with the facts, and the protection of the rights granted by the board making the grants. Irrigation law has not gone beyond this today, except in the matter of detail (Mead 1903:222).

Despite its defects, the 1880 law remained the major statute governing water use until Utah became a State in 1896. Between 1896 and 1903, the State Legislature wrestled with the problem of water use and water rights. Gradually, the State returned to a somewhat modified secular version of the early Mormon system--public control of water resources, and a power to grant or refuse rights to water vested in a central authority. Disputes over existing rights were still settled by the courts with a State Engineer supplying technical information.

Two laws passed in 1896, the State Legislature's first session, continued the practice of private ownership of water. One tried to establish a system to record and define existing rights, and the other created the Office of State Engineer. The new system for recording water rights had three serious flaws. To claim a water right, an irrigator was required to post a notice near the point of diversion, at the local post office, and at the county recorder's office, containing the following data:

(1) Volume of water claimed.

(2) Purpose or use.

(3) Place of use, and if for irrigation, the area irrigated.

(4) Means of diversion.

(5) Date of appropriation.

(6) Name of appropriator.

(7) Name of stream and description of point of diversion (Teele 1903:24).

Any water not claimed from a particular source was subject to later appropriation. There was no limit, however, to the number of claims that could be filed on a stream. Nothing in the records was required to show that any work was actually done to divert and use the claimed water (legally necessary to validate the right). Those already having rights at the time of the law's passage did not have to file to ensure the safety of their existing rights, making the public water records virtually meaningless.

The newly created State Engineer's Office was given a number of primarily technical duties by the second piece of 1897 legislation. The State Engineer was to survey and propose plans for State reservoirs and pass on the engineering safety of water development works proposed in the State. These tasks were intended to take advantage of the 500,000 acres of public lands the new State had been given to sell to raise money for building irrigation works. The State Engineer was also ordered to conduct a complete hydrographic survey of all of the State's streams and take accurate measurements of stream flow. Unfortunately, no money was appropriated to pay for this activity, and for the first 2 years, the State Engineer did very little to improve the reliability of water data.

In 1901, another law passed, expanding the State Engineer's authority and providing money for the first surveys of streams and canals. In addition, the various county commissions were instructed to divide their counties into water districts and appoint water commissioners, whose responsibility it was to measure the water and divide it among appropriators. The water

commissioners were to be supervised by the State Engineer. The counties, however, were required to pay the water commissioner's salaries, and many did not carry out this portion of the 1901 law.

Finally, in 1903, the Legislature passed a landmark statute that returned control of water to the public and placed the power to supervise water rights in the hands of the State Engineer:

> The new law gave the State Engineer considerable power. He was to possess general supervision over the public waters of the State, their measurements, apportionments, and appropriation. He was empowered to make the necessary rules and regulations pertaining to the same;...Perhaps the most important power granted and duty imposed was that he was required to make a complete hydrographic survey of the State...The data collected by these surveys was to be assembled to aid in establishing and determining the rights of the several water users throughout the State (Thomas 1920:197).

The hydrographic survey was the scientific foundation for the definition of water rights in Utah. The Legislature ordered the State Engineer to collect accurate data about stream flow and water use, and then present this information to the various district courts for a definition of the existing rights. Once the court had decided, all rights were considered legally defined unless an applicant could prove that he had not received adequate notice of the court's deliberations. Once the entire legal process, including appeals, had been satisfied, each water user was issued a certificate that was recorded in the county recorder's office, and future transfers were made with deeds, exactly like land transfers.

With the court's decree marking the base for future decisions, the State Engineer was then empowered to accept applications to appropriate any unused water, and either to grant or reject applications to appropriate, depending on the availability of water. Although the adjudication process took many years, the majority of water rights in Utah was finally defined under this system, and all grants of rights after 1903 have been made by the State Engineer.

III. IRRIGATION IN SOUTHERN UTAH VALLEY, 1850-1900

The Spanish Fork River is part of Utah's most important hydrographic system. It's waters, when merged with those of American Fork Creek and the Provo River, form the bulk of the water entering Utah Lake every year. Utah Lake is a natural reservoir, which empties through the Jordan River into the Great Salt Lake. The Utah Lake/Jordan River system provides water for the most populous valleys of the State, and the water of Spanish Fork River has long served important agricultural, municipal, and industrial uses.

The river drains a watershed area of 445,000 acres in the Wasatch Mountains east and southeast of Utah Valley. The elevations in this watershed range from over 10,000 feet at the highest peaks to 4,800 feet where the River enters Utah Lake (Doremus 1903:157). Diamond Fork Creek and Thistle Creek join Spanish Fork Creek in the upper end of Spanish Fork Canyon to form the Spanish Fork River. The river delivers at the mouth of the canyon an average of 100,000 acre-feet of water every year, with the high water months in April through May during spring runoff, and the low water months either in late summer, or mid-winter (Hudson 1962:92).

In 1900, the area irrigated by the Spanish Fork River began at the canyon mouth and ran on both sides of the river all the way to Utah Lake. Six canals irrigated a total of 27,600 acres (Doremus 1903:160). When the pioneers arrived, in 1847, the benchlands were covered with sagebrush, greasewood, and bunch grass. A scattering of cottonwoods and willows grew along the river bottom. With a steady supply of water and a much milder climate than the adjacent mountains, southern Utah Valley is well suited to the raising of a broad variety of crops, and there is little native vegetation left in the more settled areas.

Settlement began in southern Utah Valley in October of 1850, when a number of settlement groups built crude cabins along many of the area's available watercourses in anticipation of spring planting. Enoch Reece built a dugout along the Spanish Fork River bottom in 1850, and he was joined in the spring by John Holt, John H. Redd, and William Pace. This group dug a crude ditch, known as "South Ditch" from the River in Section 23, Township 8 S, Range 2 E, near the present site of the sugar beet factory (Warner 1930:139). During the summer of 1851, they planted the first crops, and by December a branch of the Mormon Church had been organized. The little settlement on the river bottom was named Palmyra, after the boyhood home of Joseph Smith, founder of the Church (Warner 1930). (This Palmyra should not be confused with a later settlement northwest of the present-day Spanish Fork). The following year, 1852, more settlers arrived, and the small South Ditch was extended. This community would

eventually move to the benchlands to the northeast and become Spanish Fork.

Other Utah Valley towns were settled in the same period and in a similar manner. A number of families settled along Peteeneet Creek and formed the town of Payson. Initially, these settlers dug wells for culinary purposes and diverted the creek water for irrigation. Peteeneet Creek proved to be a very unstable water supply, and early in the settlement period, local farmers began looking for reservoir sites. Spring Lake near Payson is a reservoir built in 1856 as storage for irrigation. During the 1860`s, a series of small dams was built in Payson Canyon to impound the spring flood waters and stabilize the flow of Peteeneet Creek (Huff 1947:453). The town of Salem, between Spanish Fork and Payson, was settled in 1851 by men from Payson because the locale had a natural spring-fed pond to provide a year-round source of water for irrigation (Huff 1947:460).

The early 1850`s were tumultuous years for the new communities. Insects destroyed a crop in 1854, and it was 3 years before the settlers could support themselves for a full year on the crops raised locally. During this early period, the Mormons lived partially off the land, gathering edible native plants, taking fish from Utah Lake, and hunting game in the nearby mountains. As settlement expanded into the Timpanogos Ute Indians` traditional resource areas, inevitable conflicts arose between the two groups, and a series of skirmishes took place. Mormon Church President Brigham Young traveled throughout the colonies at this time, urging settlers to build forts and consolidate settlements to provide better defense against attack.

These armed encounters in 1853-54 came to be known as the Walker War, named after the Ute chief who led the resistance to Mormon settlement. This conflict, a natural outgrowth of the competition for resources, lasted 10 months and eventually convinced the Utes that they would never get rid of the Whites. Brigham Young established "Indian farms" as a means to convert the Utes to agriculture. Young opened a farm near Spanish Fork in 1856, and for the next 5 years, the farm provided a source of food for the Utes (who typically slaughtered the cattle provided) and a source of income for settlers who were paid to manage the farm (O`Neil 1973). As part of the Spanish Fork Indian Farm`s development, Young constructed an irrigation ditch to the fields with Territorial funds. This ditch, however, was abandoned shortly after the Utes were moved to a new reservation in 1861 (Doremus 1903:160).

In 1855, the original settlement of Palmyra joined a growing community on the bench to the northeast, and the Territorial government granted a charter for the new town of Spanish Fork. Spanish Fork, like Payson and Salem, was a typical Mormon farm village. Mormon pioneers developed a unique system for settling the arid West. In Midwestern States, Federal land policy forced the development of isolated homesteads, according to the availability of 160-acre tracts. In Utah, however, the Church encour-

aged the formation of small communities, with large farm "fields" surrounding the town, and farmers typically traveled 1 to 5 miles everyday to work individual plots of 30 to 60 acres. This system had its roots in the "Plat of Zion" concept of the Mormon Church founder, Joseph Smith. It had several practical advantages as well--increased protection from attack, and more efficient use of available tools and implements. It also provided a closer knit social structure that fostered more services, community cooperation, and pooling of resources for larger projects, such as irrigation systems. Within each community, every farmer was given a lot large enough for a garden, small orchard, and a barn/corral.

Included in the city charter for Spanish Fork was the power to control all the water of the Spanish Fork River (Warner 1930:139). As most of these settlements were populated by farmers, and run for the benefit of agriculture, the granting of irrigation water rights to cities in early Utah was quite common.

> For the first twenty years after the settlement of the Territory, practically all the towns were given control, when their charters were granted, of irrigation water within their limits. And as the city limits in most cases included the adjacent farm lands, that meant all waters used by the inhabitants of the communities for garden and crop production (Thomas 1920:94).

The Spanish Fork City government exercised this legislative authority to the fullest, dividing the river`s waters between the various farming districts or "fields" that surrounded the town. The City also appointed watermasters to regulate the canals, and levied a tax to defray maintenance expenses.

The City soon granted charters to the farmers in the various "fields" to form companies, to elect officers, and to pass laws governing the uses of land and water in their district. In 1859, the West Field and South Field were given the right to incorporate. The South Field Irrigation Company was formed immediately, and the South ditch expanded further. West Field Farmers waited until 1883 to incorporate, but they continued the operation of their canal on an ad hoc basis. As the population continued to grow, the City Council settled on a simple expedient for dividing the waters of the river. In March 1865, they divided the entire flow of the river. The property owners west of Main Street receiving rights to one half, and the property owners east of Main Street got rights for the other half. Between 1865 and 1867, farmers from Salem and Payson were granted rights to a portion of the Spanish Fork River and built the Salem Canal, but it was not until 1878, that they officially incorporated the Salem Canal Company (Huff 1947:461). During the 1870`s, three other major canals were built to divert water from the Spanish Fork River. In 1873, the Mill Race Canal Company built a dam for $1,700 across the river to divert water into what was to become the largest of the canals on the Spanish Fork River (Doremus 1903:160). In February 1876, 35 farmers living on what had

previously been the Spanish Fork Indian Farm were granted the right to divert water, and they formed the Lake Shore Canal Company (Huff 1947:397). Two months later, settlers on the benchlands east of Spanish Fork, petitioned the City Council for enough water for 3,000 acres and 200 town lots, but the report of a special committee of the Council replied that all of the primary rights to the river had been granted, and the East Bench Company could have only secondary rights during spring runoff and the years of higher than normal flow. In other words, the City Council felt that all of the primary rights had been appropriated by 1876, and drought years would see the farmers on East Bench unable to raise crops (Warner 1930:141).

Within the limits of the existing technology, the natural limit of the resource had been reached, and disputes over water soon began in earnest. Settlers continued to move into the area. In years where there was plenty of water, everyone made a living. The primary rights to the river, however, were very vague, having never been determined except by the maximum volume the canal could carry. There were no restrictions as to the volume of water granted, the area to be irrigated, or the length of time the water could be used. The original six canals were also kept continuously full, and the unused portion flowed back into Utah Lake. A similarly indefinite appropriation was made to the East Bench Company for the secondary rights to the river, and some of the older canals expanded and further appropriated secondary rights. A. F. Doremus describes the situation on the Spanish Fork River in the early 1880`s:

> Expansion continued. No one stopped to consider whether the limit had been reached or whether it had been exceeded. All were intent upon the present. Then followed a season of deficient snowfall, and the river failed to furnish a volume equal to the customary diversions. That all could not enjoy the usual supply was evident. How should the inevitable be met? Public meetings were held; the situation was discussed; concessions were made. The water was finally apportioned irrespective of right, for the purpose of equalizing the loss over the entire system. The result was that, while the general loss was considerable, the individual loss was inappreciable. The work of expansion was, however, checked. The question of rights was born and took form in contention over what constituted "primary" and what were "surplus" rights. Division of the water users into two classes soon followed (Doremus 1903:163).

With the 1880 water law now in effect to guide the division of the river`s waters, the City Council of Spanish Fork, following the custom of the Territory, recommended that the canal companies settle the issue of primary and secondary rights before the High Council of the Utah Stake of the Mormon Church in 1887. After hearing testimony from the five canal companies, the High

Council divided the river's "normal" flow into 24 parts, and gave each of the existing companies the following primary rights:

(1) West Field and Spanish Fork City, 11/24.

(2) East Bench, 2/24.

(3) Salem, 4/24.

(4) South, 6/24.

(5) Lake Shore 1/24.

The High Council's decision put a temporary halt to serious water disputes, but without having settled the issue of secondary rights, problems eventually arose again. One of the key debates in the ensuing contention was what amount of water constituted a "normal" flow. Without adequate technology for measuring flow, the watermasters of the five canals were left to decide between themselves when the primary rights had been satisfied, and secondary right holders could begin irrigating. A. F. Doremus describes some of the headaches this situation created:

> In the absence of definite knowledge as to what constituted the volume at the stage of normal flow, there was no lack of ground for dispute...Had each appropriation been for a fixed volume and time, and had public record been made of the evidence of these, together with the date of diversion, the rights in the stream at normal or at any other designated stage of flow could easily have been determined. This had not been done and retribution was at hand. Then it was that one class, contending that the surplus water had been exhausted and that, as appropriators of the normal flow, they were entitled to the whole stream, would proceed in force and shut off the supply from those whom they regarded as belonging to the other class. These, insisting that there was still surplus water in the stream, would retaliate by restoring their supply, with a little added, as soon as the first force had retired. Thus was inaugurated a war which has continued to the present time, and which is typical of the strife that exists among water users throughout the State, involving a measureless expenditure of time and money, limitless ill will, and often human life itself (Doremus 1903:164).

During the 1890's, residents of southern Utah Valley tried repeatedly to have their rights adjudicated and settled in the district court, but without success. Over a dozen cases were tried between individuals and between canal companies. Each partial court decision, seemed only to provide grounds for another case (Doremus 1903:164; Mead 1903:226). Finally, in 1899, all of the Spanish Fork River water users combined in a

lawsuit before the district court. On April 20, the court defined the normal flow, primary and secondary rights, and appointed the watermasters of the five canals as commissioners to divide the water according to the decree. In dividing the River's primary rights, the district court followed the Utah Stake High Council's decision and divided the "normal" flow into 24 parts. The court, however, made an attempt to define the normal flow as that volume of the river just below the mouth of Spanish Fork Canyon that is "15 1/2 inches in depth by 24 feet in width." What the court omitted was the speed at which the water passed through that area, making the precise measurement of the volume of water impossible.

Secondary rights were defined as those between 25 inches in depth and 15 1/2 inches in depth measured over the same 24 feet. Anything above this was put in a third class of rights, for use primarily by the small number of farmers irrigating fields in Spanish Fork Canyon itself. The 1899 decree was popularly viewed as having fixed for all time the rights to water in the river, although it had several serious technical deficiencies (Doremus 1903:167).

The rapid population growth in southern Utah Valley during the latter years of the 19th century forced this kind of explicit division of the River's waters. By 1900, it was clear to everyone in the area's small farming villages that there was just not enough water to go around and some other means had to be found to increase the water supply. This problem was not limited only to southern Utah Valley. It was a problem to farmers and stockraisers all over the arid West, a problem that the Federal Government was being pressured to help solve.

IV. THE FEDERAL ROLE IN THE WEST, 1879-1902

Since the formation of the Republic in 1789, the American Government has had 1.4 billion acres of public lands to manage or dispose of as it saw fit. For the first 50 years, public lands were sold to pay the operating costs of the Government. At one point, it was even impossible to buy less than 640 acres. As the middle of the 19th century approached, however, the Nation realized "that the public domain was worth more as a means of providing homes than for its contributions to the running expenses of the Government, and changes were made that would favor its disposal in tracts suited in size to the needs of a settler and his family" (Mead 1903:14). In 1841, Congress passed the Preemption Law, which gave 160 acres of land to anyone who would pay $1.25 per acre, settle on it, and begin growing crops. The 1862 Homestead Act went even further, by allowing a settler to gain title to 160 acres of public domain simply by living on the property, and waived the $1.25 and the requirement for cultivation.

The Homestead Act worked quite well in the settlement of the Midwest and Northwest, where adequate rainfall and a little diligence would likely result in a successful farm of the size a family could handle. During most of this period, agriculture was viewed as an industry that required little capital investment to get it started, and a farmer could essentially build a small business solely with his own labor. As such, it was ideally suited to the building of the new Nation, and to the successful absorption of the waves of immigrants coming to America. The amount of land an individual could acquire from the public domain continued to expand, with the passage of the Timber Culture Act in 1873 (160 acres to anyone who would plant trees on 1/4 of it) and the Desert Land Act in 1877 (640 acres to anyone who would irrigate it and pay $1.25 an acre). The passage of the Desert Land Act accelerated the transfer of land along the West's major waterways into private hands, but the vast majority of the public domain west of the 100th meridian remained undeveloped.

Between 1870 and 1890, there was a rapid rise in the number of irrigation works built in the West (Mead 1903:344), including many built privately by individuals, those built by the cooperative efforts of Western communities, and some constructed as profit-making ventures by businessmen from all over the world (particularly Great Britain). By the last decade of the 19th century, however, a number of factors combined to stall water development. The disastrous winter of 1886-87 wiped out a large portion of the range cattle industry and bankrupted many who were building canals for their stockraising operations. Low farm prices after the panic of 1893 shrank the farm economy and slowed Western immigration. In addition, much of the easily obtainable water had already been appropriated and the chaotic situation over the definition of rights resulted in much costly litigation

and delayed development. Federal land policies inhibited the private development of large projects as well.

The Bear River Canal in Utah is an excellent example of how the Federal land laws ruined many feasible private projects. When word of the Bear River Canal survey spread throughout Utah and Idaho in 1889, speculators rushed to file homestead patents along the right-of-way for the proposed canal. Another 45,000 acres in the area under the canal had already been purchased from the railroad land grant of the Union Pacific, meaning over half the proposed irrigation area was already in private hands when construction began. There was nothing in the Homestead Act that required cultivation of the land, only settlement for a short period of time. The vast majority of the property owners, therefore, held their land, saved themselves the expense of farming it, and waited for the property value to increase upon completion of the canal. The speculators could then sell the land later to actual settlers at a handsome profit. The Bear River Canal Company, however, had a mortgage and operating costs to meet, and little income from the sale of water to farmers. In 1894, the company went bankrupt, and the $2-million canal was purchased for $125,000 (Thomas 1920:203). A similar fate befell many corporate canals all over the West.

During the 1890's, it was widely recognized that most of the easily obtainable water had been appropriated. The large storage and diversion works needed to develop more water were obviously beyond the financial resources of small communities, or the narrow economies of Western States, and private corporations stood an excellent chance of losing their shirts under the existing laws. This recognition coalesced in what later became known as the "Irrigation Movement," a movement led by a group of Westerners pursuing with missionary zeal their vision of "practical statesmanship"--Federal involvement in the development of water. The scientific founder and a leader of this movement was Major John Wesley Powell, explorer of the Colorado River, and topographer, geographer, and ethnographer of the Colorado Plateau and Southwest. During his famous voyage down the Colorado River in 1872, in and subsequent explorations, Powell realized the agricultural potential of the West if its great rivers could be diverted for use. Powell made a preliminary examination of arid public lands, first under the auspices of the Smithsonian Institution, and later under the United States Geographical and Geological Survey of the Rocky Mountain Region. In 1879, he published what has become a classic document in the development of the West, Report on the Lands of the Arid Region.

The following year, Powell became Director of the newly formed United States Geological Survey (USGS) and began lobbying Congress for an appropriation to conduct a series of irrigation surveys. In October 1888, Congress appropriated $100,000 "to investigate the extent to which the arid regions can be redeemed by irrigation" (Reclamation Service 1903:35). Published in the four USGS annual reports between 1888-1891, these irrigation studies had two significant germinal effects on Federal involve-

ment in water development. They provided the first hard, scientific information about the West's major river systems, including yearly stream flows, existing water rights and uses, and possibilities for future development. Perhaps equally important, Powell's irrigation surveys trained a generation of engineers and geographers in the hydrography of the West, a group that later went on to run the Reclamation Service.

In 1888, Powell dispatched Frederick Haynes Newell, later first Director of the Reclamation Service, to Utah to study the water supply situation. During the first year, Newell concentrated on improving the water supply to the populous Salt Lake Valley, primarily because he felt the higher property values would guarantee viable water projects. Appalled at the total lack of hard data on stream flows, he immediately established gauging stations "At all of the principal streams which flow from the Wasatch into the Salt Lake Basin,...including Provo River, American and Spanish Fork" (Powell 1889:88).

Newell remained in Utah 3 more years, improving on and expanding his hydrographic studies and investigating the technical feasibility of various proposed projects. He made extensive surveys of the Bear, Weber, Jordan, and Sevier River systems, but also spent considerable time studying Utah Lake. Newell made an important discovery in 1890-91. After determining the rate at which water evaporates in Utah Valley, he calculated that the broad, shallow shape of Utah Lake evaporated the entire flow of its principal tributary, the Provo River, every year. Newell proposed that if the Lake could be made deeper, with less surface area, a far greater amount of water would be available for Salt Lake County (Powell 1891:334). The following year, Newell was promoted to Director of the USGS Hydrographic Branch, and was replaced by A. H. Thompson, who drew up a list of 13 good Utah reservoir sites for the final volume of the Irrigation Surveys.

In February of 1889, 4 months after launching the USGS Irrigation Surveys, the Senate formed the Select Committee on Irrigation and Reclamation of Arid Lands, and chose several Western Senators to begin the long process of arousing the public to support the idea that the Federal Government should in some way take up the difficult task of Western water development. In the summer of 1889, the Select Committee toured Western States and held hearings. The Committee's report, coupled with Powell's irrigation surveys, began to stir public inerest in water development.

A severe drought in 1890 blighted the Western Great Plains and, finally, sparked a national movement for Federal irrigation projects. William E. Smythe, then a resident of Nebraska, became interested in irrigation during the drought. In his book, Conquest of Arid America, Smythe records his feelings about the drought:

> In 1890, I was an editorial writer on the Omaha Bee,...During the previous summer, I had made a brief trip to the Maxwell Land Grant in New Mexico and for the first time saw men engaged in turning water upon land to make good the deficiencies of rainfall. I suppose I had heard or read the word "irrigation," though I have no recollection of it. Certainly, the word meant nothing to me until the drought struck Nebraska a year later. Then the thought occurred to me that the several fine streams flowing through the State might be employed to excellent advantage. Men were shooting their horses and abandoning their farms within sight of these streams. There was the soil, the sunshine, and the waters, but the people did not understand the secret of prosperity, even with such broad hints before their eyes (Smythe 1905:266).

A series of irrigation conferences in Nebraska grew into a State convention, which made Smythe Chairman of a committee to organize a National Irrigation Congress. Smythe's efforts struck a responsive chord in other Western States, and a year later in September 1891, the first National Irrigation Congress was held in Salt Lake City "within sight of the historic ditch on City Creek where English-speaking men began the conquest of the desert" (Smythe 1905:267). The first congress advocated a plan where the Federal Government would cede all public lands in each State to the State governments, which would then begin the work of building large reclamation projects. This plan was approved without a dissenting vote.

The cession movement sparked a National debate, however, about the ability of Western States to finance the reservoirs and diversion works without selling off vast portions of the surrendered public domain. The irrigation movement was soon being denounced as a "gigantic scheme of land-grabbing" (Smythe 1905:269). The second congress in Los Angeles in 1892 responded to this criticism by calling for National involvement in water development, but the participants held little hope that they would see Federal aid in their lifetimes. While the cession movement was all but abandoned by the irrigation congresses, it did result in the passage in 1894 of a bill based on that principle, which Senator Carey of Wyoming had introduced each session since 1886.

The Carey Act, gave each State the right to select up to a million acres and control its settlement and irrigation with the approval of the Interior Department. Senator Carey took advantage of the experience of Elwood Mead, then Wyoming State Engineer and later third Director of the Reclamation Service, in formulating the Act. Mead had been one of the consulting engineers on the Bear River Canal Project, and had seen the disastrous effects of the Homestead Act on corporate irrigation projects. Consequently, the bill Carey introduced attached the right of water use to the land, so that neither the canal builder

nor the irrigator owned the water. There was no way to speculate on the land, since the cost of running the canal was assessed on the land and those not cultivating it would have to pay a yearly fee (Mead 1903:26).

The Carey Act produced only sporadic development in the West. Most of the projects built were undertaken by private corporations trying to sell the land at a profit. The economic conditions in the 1890`s tended to limit the scope of these projects. Utah`s experience with the Carey Act was typical of many Western States. Utah became a State in 1896, two year`s after the Act`s passage, but it was not until 1901 that the Legislature passed the necessary enabling legislation and the State began studying Carey Act proposals. Between 1901 and 1920, 25 applications totaling 830,000 acres were made, but only 23,000 acres were actually reclaimed in Utah. This acreage represents only a small fraction of the 600,000 acres estimated to have been potentially irrigable at the time (Thomas 1920:243), and clearly indicates that private capital and the State Government were largely unsuccessful in implementing the Act.

Throughout the 1890`s, the Irrigation Congress met in various Western cities and gradually escalated their efforts to win a National commitment to reclamation. At successive congresses, they advocated the reform and standardization of State water laws, the repeal of the Desert Land Act, increased appropriations for hydrographic surveys, and the creation of a National commission to formulate a plan for arid land reclamation (Smythe 1905:270). By 1897, the irrigation movement recognized that a full-time lobbying arm was needed if progress was ever to be made in winning congressional and public support.

At this juncture, an energetic young lawyer from California, named George H. Maxwell, stepped forward, and in 1897 formed the National Irrigation Association. Maxwell immediately began searching for funds for his new organization, and was quite successful in fund raising with mining, manufacturing, and transportation companies in the West who would benefit from an improved economic base (Smythe 1905:272). Within three years, the Ninth Irrigation Congress in Chicago unanimously adopted a resolution calling for a comprehensive National plan for reclamation, a resolution that found its way into the platforms of the Democratic, Silver Republican, and Republican Parties during the elections that fall.

Between 1880-1900, Western congressmen had doggedly introduced bills for irrigation projects in their individual States. Invariably, they could not get other Western Senators to support bills which did not benefit their home districts. Eastern and Southern Congressmen saw no reason, as well, why the taxes of farmers in their districts should go to create new agricultural competitors in the West. With both national parties calling for a comprehensive reclamation plan, Western Congressmen began introducing legislation immediately during the fall and winter of 1900-01. Colorado Representative John Shafroth introduced a bill

appropriating $13 million from the National Treasury to begin construction immediately. Representative Francis Newlands of Nevada and Bell of Colorado also asked for money for projects in their home districts, but the resistance of Eastern and Southern Representatives was unwavering. Francis Newlands then began studying other alternatives that might be more acceptable to the House of Representatives. Newlands described how he hit upon the final form of the Reclamation Bill:

> As the Committee hearings progressed, it soon developed that members differed greatly, and I came to the conclusion that we could not hope to persuade the East until the men of the West were united. And so, with a view to shaping a broad and comprehensive national measure that would receive the support of and include the entire arid region, I made a careful study of all previous bills, including those of Mr. Shafroth and Mr. Bell, from which most valuable suggestions were received. I also consulted Mr. Newell of the United States Geological Survey, Mr. Maxwell of the Irrigation Association, and Mr. Elwood Mead and other irrigation experts who differed widely as to the form of legislation; and finally, on the 26th day of January 1901, I introduced in the House a bill which contained every essential feature of the Reclamation Act that is now upon the statute book (Smythe 1905:289).

Newlands invited Congressmen from the 16 Western States to his home, where they discussed the bill and eventually took an informal vote among themselves to support it. Within the last 6 weeks before adjournment in the summer of 1901, Newlands' bill cleared the Senate Committee on Public Lands and was almost through the House Committee on Irrigation.

During the recess, however, the Wyoming State Engineer (not Elwood Mead, who had since become Director of Irrigation Investigations for the Department of Agriculture) began organizing other Western States officials to oppose the nationalizing of water development. The State Engineers submitted an amendment that called for National funding of irrigation projects that would be controlled in each State by the State Engineer. When Congress convened in the fall of 1901, the Western Congressmen met to resolve the dispute between the two views. After an extensive debate that took almost a month, the issue was decided in favor of National control, and the bill was reintroduced into both the Senate and House.

In 1901, President William McKinley was assassinated, and Theodore Roosevelt became President. Roosevelt, although born and partly raised in the East, had spent many years in the West, both as a hunter and as a rancher in North Dakota. On December 3rd 1901, in his first address, the new President spoke strongly in favor of irrigation and challenged the Eastern and Southern

Congressmen to take a broad economic view of National irrigation projects:

> The reclamation and settlement of the arid lands will enrich every portion of our country, just as the settlement of the Ohio and Mississippi valleys brought prosperity to the Atlantic States. The increased demand for manufactured articles will stimulate industrial production, while wider home markets and the trade of Asia will consume the larger food supplies and effectually prevent Western competition with Eastern agriculture. Indeed, the products of irrigation will be consumed chiefly in upbuilding local centers of mining and other industries, which would otherwise not come into existence at all. Our people as a whole will profit, for successful home making is but another name for the upbuilding of the nation (Reclamation Service 1903:44).

The original Newlands bill embodied an idea that solved most of the political problems that had snagged irrigation legislation for two decades. The bill proposed to take money from the sale of public lands in the 16 arid States and place it into a Reclamation Fund, which could be used at the discretion of the Secretary of the Interior to pay for engineering surveys and for actual construction costs. Since no money was actually being appropriated from general revenues to pay for Western public works, Eastern opponents were put in a position of having to argue against spending money paid by Western settlers to provide irrigation for Western homesteads. The Newlands bill also quieted Western rivalries by dividing public land sales by State, and making provisions for reinvesting that money in each State.

During the spring of 1902, the Newlands bill was worked and reworked in House and Senate committees, but the measure that finally emerged on June 13, 1902 was very similar to the measure Newlands introduced a year and a half earlier. As a Republican President, Roosevelt was particularly helpful in the pitched battle that occurred in the House. Republican Congressmen, primarily from the East, put up a determined opposition, but Roosevelt was able to persuade them to at least not actively oppose the bill, just vote against it. On June 17, Roosevelt signed the National Reclamation Act of 1902, popularly known as the Newlands Irrigation Act (Smythe 1905:287), and Frederick Haynes Newell was named first Director of the Reclamation Service.

The Act established policies for the development of water projects and set aside all moneys from the sale of public lands in 16 Western States during the fiscal year ending June 30, 1901, less 5 percent that since 1890 had gone to support Western Agricultural Colleges. As of January of 1902, $3.44 million had become available, enough to get the first surveys underway that summer. By January of 1903, another $4.6 million had been secured. Based on 20 years of hydrographic surveys, the engi-

neers under Frederick H. Newell at the USGS Hydrographic Branch already had an excellent list of potential projects when the law was passed. Newell immediately asked the Secretary of the Interior to withdraw lands from the public domain for five projects, so they could be studied without a rush of speculative filings (Reclamation Service 1903:65-66).

The Newlands Act had 10 sections. Section 1 created the Reclamation Fund from the sale of public lands. Section 2 defined the duties of the Secretary of the Interior, and authorized him to survey public lands for feasible irrigation works, including dams, canals, and wells, and then expend the money needed to construct these works without congressional approval for individual projects. The Secretary had to make a yearly report, however, covering all the current survey and construction activities under the Act.

Sections 3 and 5 governed the disposition of public lands destined to be part of a project. Section 3 gave the Secretary of the Interior authority to withdraw lands both for the irrigation works themselves, and the land that would likely be irrigated. Most important, Section 3 allowed him to withdraw the land prior to any engineering work without giving public notice, to avoid the type of speculation that killed the Bear River Canal. Section 5 took the land entry procedures of the Homestead Act and modified them to the needs of irrigated agriculture. An entry was limited to between 40 and 160 acres, with the average farm size in each project left to the discretion of the Secretary. Newell urged in the first Annual Report that initially the farm size be kept small, 40 acres or slightly more, saying "Throughout the greater part of the arid region the consensus of opinion seems to be that 40 acres of good land, with ample water, are sufficient for a homestead" (Reclamation Service 1903:68). The Homestead Act required only settlement upon the land, but the Reclamation Act added the requirement that settlers must cultivate at least half the entry and pay the assessed project costs before receiving the patent and ownership. The repayment costs of the project, plus a yearly maintenance fee, were assessed directly on the land, and if an entryman missed two payments, the entry was cancelled.

The Secretary of the Interior is given, in Section 4, the right to assess a cost per acre that would result in the repayment of the project in 10 years. The Secretary of the Interior was also given the right to sell water rights to private landowners under Reclamation Service Projects, provided the water was sold for no more than 160 acres. In addition, no water could be sold to a parcel of land unless the owner was a resident on the land and cultivating it. A special clause in the Act allowed residence "in the neighborhood," a provision designed to allow projects in Utah under the farm village settlement pattern. Mormon farmers rarely lived on their property, and a residence requirement would have excluded most towns in Utah from enjoying the benefits of the act.

Section 6 of the Act allowed the Secretary to use money in the Reclamation Fund for the operation and maintenance of completed projects. It also stipulated that once the costs had been repaid, the management and operating costs would be turned over to an association of water users. Newell advocated the formation of these associations prior to complete repayment, however, because he felt it would be more "convenient and satisfactory" if the water users collected payments and were responsible for the entire yearly repayment to the Reclamation Fund.

Section 7 gave the Secretary of the Interior right to purchase or condemn private property needed for the completion of projects. Section 8 restricted Federal projects from interfering with either existing water rights, or acting in ways contrary to State water laws, and spelled out the nature of water rights under Reclamation projects; i.e., water rights are "appurtenant" to the land, and beneficial use is the "basis, the measure, and the limit" of the right. If a water right was not used, the right would be cancelled and the homestead entry on public land opened up to someone else.

Section 9 had important implications for the first few years of the Reclamation Service. It required the Secretary to spend the major portion of moneys derived from the sale of public lands in the State in which they originated. Newell interpreted this requirement to mean that 51 percent of each State's funds had to be spent there, and the other 49 percent went into an unrestricted fund. To take full advantage of the Reclamation Fund, projects had to be started in each of the original 16 Western States, a move which helped mollify the interstate rivalries over Federal funds. During the first 3 years, Frederick Newell made a concerted effort to find feasible projects in each State, and set himself a goal of having one launched in each State before the end of 1905. With a December 15, 1905 authorization date, the Strawberry Valley Project made Utah the last of the original 16 States starting a project, a delay caused by the difficulty of settling existing water rights under Utah's legal system (Reclamation Service 1903:64-75).

V. THE STRAWBERRY VALLEY PROJECT--PLANNING

Who originated the idea for the Strawberry Valley Project? The historical record is not clear. Some sources credit Henry Gardner, founder and president of the Commercial Bank of Spanish Fork, and a local political leader and Mormon stake president (Bureau of Reclamation 1955:5; Warrum 1919:323). Noble Warrum's Utah Since Statehood contains a brief biography of Henry Gardner, which says he was "the originator and prime mover in the building and completion of the Strawberry tunnel" (Warrum 1919:323). Other histories, however, give the honor to Heber C. Jex, Mayor of Spanish Fork between 1900-1910, and also a religious commercial leader of Spanish Fork (Warner 1930:145). The diary of Heber C. Jex, preserved in The Church of Jesus Christ of Latter-day Saints Archives, contains the following entry, dated July 19, 1902:

> As per arrangements which I had made with Frank C. Kelsey, C.E. of Salt Lake City, he, Kelsey, Wm. O. Jones, City Councilman, and I left for Strawberry Valley to look into the prospects of bringing the Strawberry Valley waters over into our valley. We estimated the little and big Strawberry creeks would equal in flow the Spanish Fork River, and Engineer Kelsey said it was a feasible thing to bring the Strawberry water into the head of Diamond Fork by means of a tunnel. I therefore filed on the waters of the valley as Mayor of Spanish Fork, for the benefit of its citizens. I had taken with me a blank form to be filled in for said appropriation (Jex 1902).

Population increases coupled with the scarcity of water in the older, settled valleys between 1890 and 1900 created a climate which forced local political leaders all over the State to look for new sources of water for their communities. A severe drought in 1888 reduced most of southern Utah Valley's major creeks to a trickle, and all but the oldest water right holders lost their crops. Over 40 percent of the crops were lost that year. (See Table 1.) In anticipation of the visit of the Senate Select Committee on Irrigation and Reclamation of Arid Lands during the summer of 1889, the citizens of southern Utah Valley attended a series of mass meetings in May and June to discuss proposals and prepare testimony for the Committee's Salt Lake hearing. In his testimony before the Senate Select Committee, John Luckett of Springville described an irrigation proposal drawn up by a local committee, which he chaired:

> A series of mass-meetings held in Springville on the 12th, 27th, and 31st of May 1889, also one on the 17th of June, consisting of citizens of what is known as Mapleton Ward which embraces an area of about 9 square miles, and is the southern and eastern portion of Springville corporate limits, resulted in a...committee

TABLE 1

ACRES OF LAND CULTIVATED, ACRES THAT COULD BE CULTIVATED WITH INCREASE OF WATER, AND ACRES OF CROPS LOST THIS YEAR FOR WANT OF WATER

Name of Precinct	Natural Streams	When Appropriated	Canals in Each Precinct	Cultivated	Could be Cultivated with an Increase of the Water Supply	Water per Second	Crops Lost This Year for Want of Water
			Miles	Acres	Acres	Cu. ft.	Acres
Cedar Forte	North Cañon Creek and Fort Springs	1854	18	500	76,000	12	400
Fairfield	Fairfield Springs	1855	2	300	2,000	3	None
Goshen	Salt Creeks	1852-1878	18	1,500	60,000	15	500
Lehi	Ory Creek and Spring Creeks	1851	30	7,800	5,000	20	3,334
Alpine	Dry Creek Springs	1850	25	1,400	1,300	15	1,300
American Fork City	American Fork River, Battle Creek and Provo River	1851	25	4,291	7,000	21	3,840
Pleasant Grove City ...	American Fork River and Grove Creek	1852	20	6,500	3,700	21	2,000
Santaquin City	Summit Creek	1852	15	500	7,000	9	800
Spring Lake City	Spring Lake	1851	4	300	600	3	100
Payson City	Spring Creek and Peteeneet and Salem Canal	1851-1867	50	2,000	19,000	21	3,000
Spanish Fork	Spanish Fork River	1854-1889	114	1,192	14,880	24	5,313
Springville	Hobble Creek and Spring Creek	1851-1880	95	5,025	7,000	17	1,700
Provo City	Provo River and Rock Cañon Creek	1871	175	16,000	9,000	95	800
Benjamin	Spanish Fork River	1876	20	5,000	6,526	12	2,500
Lake Shore	....do.....	1866	25	3,840	3,840	8	2,000
Salem	Spanish Fork River and .... Springs	1869	26	2,250	2,200	12	1,390
			662	69,126	255,046	308	28,977

Source: (Luckett 1890).

to represent to the Senate Committee on Irrigation in the Territory the necessity of irrigation in...Mapleton Ward.

> The object of this communication is to show...the result of the labors of a previous committee appointed by a...series of mass meetings to ascertain if the waters of Strawberry Creek, in Strawberry Valley, and lying in the Indian reservation, could be brought into Springville through Spanish Fork Canyon for irrigating purposes.
>
> The committee...on Strawberry reported as follows to the mass meeting held June 17, 1889:
>
> That the water of Strawberry can be taken into Spanish Fork River by constructing a ditch 20 miles in length, with a tunnel through the dividing summit 600 feet long. The amount of water thus obtained will exceed the water running in Hobble Creek, or five or six good irrigating streams.
>
> Nearly the whole of the...southern and eastern portion of Springville is now without water in consequence of the decrease of Hobble Creek, the older water claims taking precedence, and leaving Mapleton people with their grain, fruit, and shade trees already perished. Our hopes are that through Government means something may be done for our relief in the near future (Luckett 1890).

Luckett also presented the data summarized in Table 1 before the hearing, which showed that after a half century of development in southern Utah Valley, 76 percent of the land remained untilled from lack of water.

Another serious drought in 1900-01 brought the situation to a head. The level of Utah Lake fell so low that the Jordan River stopped flowing into Salt Lake County, and Jordan River water users were forced to install pumps on Utah Lake to drain the remaining water to meet the needs of only the primary right users (Utah State Engineer 1902:7). In 1901, a project quite similar to the Strawberry Valley idea, called the Gooseberry Reservoir Project, was already in the planning stages in Sanpete County. The Gooseberry Project was the brainchild of the Mammoth Reservoir Company, a cooperative organization of Sanpete canal companies. The company proposed to build a dam to impound the waters of Gooseberry Creek, a tributary of the Price River in the Colorado River Basin, and drain that water through a 2 1/2-mile tunnel into the San Pitch River to irrigate Sanpete and Juab County farms in the Great Basin (Utah State Engineer 1902:10).

The Mammoth Reservoir Project's dam failed a few years later, and the Project never succeeded in transferring water from the Colorado River Basin to the Great Basin, but one group of Utah farmers had managed to make small scale diversions. Since

1882, farmers in the Heber Valley had been diverting the water of Strawberry Creek across the divide into the Great Basin. Between 1879 and 1882, Hyrum Oakes and 50 other Heber farmers constructed the Strawberry Canal, a 3-mile long ditch with a capacity of "200 miner`s inches" (MacKay 1982; Babb 1902), and in 1883, formed the Strawberry Canal Company. In 1888, Joseph C. and James McDonald began another, smaller canal, to divert about 50 miner`s inches of Hobble Creek water 2 miles over the divide (Babb 1902). In 1890, the Strawberry Canal Company, in search of more water, invested $15,000 in the Willow Creek Canal and Tunnel, but failed to complete their construction. Eventually, another group of 45 Heber Valley farmers took the project over, finished it, and incorporated it as the Willow Creek Canal Company in 1893 (MacKay 1982:72).

At the time these three canals were built, the Strawberry River was part of the Uintah Indian Reservation, which had been drawn to include all of the Duchesne River drainage. The Utes had legal title to the water. After 1893, the Willow Creek and Strawberry Canal Companies began a 6 year effort to gain legal rights to the the Strawberry River water that they had appropriated. As a first step, a lawyer was hired to survey and plat the canals and fields, and apply for rights with the Secretary of the Interior. In 1894, Territorial delegate Joseph Rawlins tried to get a special act passed permitting the diversion of water from the reservation based on the lawyer`s plats. During the same congressional session, other business interests in Utah and Colorado were making a concerted effort to have the reservation opened to settlement under the Dawes Severalty Act, and give each head of a Ute family 80 acres, and 40 acres to each individual (Act 8-15-1894, 28 Statutes 337). When Utah became a State in 1896 and was able to elect a full congressional delegation, Rawlins became a Congressman. In 1899, he succeeded in having an amendment attached to an Indian Appropriations Act giving the Secretary of the Interior authority to:

> grant rights-of-way for the construction and maintenance of dams, ditches, and canals, on or through the Uintah Indian Reservation in Utah, for the purpose of diverting, and appropriating the waters of the streams in said reservation for useful purposes: Provided that all such grants shall be subject at all times to the paramount rights of the Indians on said reservation to so much of said waters as may have been appropriated, or may hereafter be appropriated or needed by them for agricultural and domestic purposes (Act 3-1899, 30 Statutes 941).

With the opening of the southern portion of the Uintah Indian Reservation in 1897-98, to agricultural and mineral development, pressure mounted immediately for giving the northern Utes around Whiterocks their allotments and opening the northern portion as well. Having the Strawberry and Willow Creek Canal Companies` requests for legal rights in hand, and facing the

imminent opening of the northern part of the reservation, the Department of the Interior commissioned a survey in 1899 by Cyrus C. Babb to determine the extent of the reservation's water supply and the amount of irrigable farmland available for allotment (Babb 1902). Babb finished his work in 1901, and Secretary of the Interior E. A. Hitchcock refused to grant diversion rights for the three canals until all the Utes had received their allotments and an irrigation system for their lands had been "perfected" (Hitchcock, In Babb 1902). Frederick Newell, at the time Chief of the USGS Hydrographic Branch in Interior, outlined the reason for delaying the grant of rights:

> At present, and for many years in the future, the supply of water on the reservation is enormously in excess of the uses by the Indians, but in view of the future needs of the lands which may be allotted to the Indians, there is not much water which can be appropriated without injury to these prospective wants (Hitchcock, In Babb 1902).

Wasatch County farmers had made other attempts during this period to use the resources of the Strawberry Valley area. Beginning in the 1880's, they moved cattle and sheep over the divide into the Valley and grazed this stock illegally on the reservation. A succession of Indian Agents tried unsuccessfully to get the stockmen to pay lease fees. Finally, in desperation, the Utes leased the Strawberry Valley grazing rights to Charles Homer of New York, in hopes that he would keep the local ranchers out (MacKay 1982).

In general, during the 1890's and early years of the 20th century, Utahns looked with increasing interest at the reservation's land, water, and mineral resources for the State's economic expansion. When Utah became a State in 1896, a State Board of Land Commissioners was created to govern and dispose of lands Utah had acquired from the public domain to sell for various purposes. One of the first actions of the Board was to undertake an agricultural and hydrographic survey of the reservation (Utah State Board of Land Commissioners 1896). With water in short supply across the divide in the Great Basin, political leaders hatched a series of schemes to appropriate and use reservation water. These efforts were galvanized by passage of two Federal laws, one opening the northern portion of the reservation for settlement, and the National Reclamation Act in June 1902.

Immediately after President Theodore Roosevelt signed the Reclamation Act, Frederick Newell began a Western tour to preach the virtues of the new law, and to meet with irrigation leaders in each State and learn of possible projects. Spanish Fork's local paper, The Spanish Fork Press, reported weekly on Newell's progress around the West (The Spanish Fork Press, July 24, 1902). The passage of the Reclamation Act coming on the heels of the 1900-01 drought stirred quite a bit of ferment in southern Utah Valley about increasing the water supply. The City of Spanish Fork, on August 5, 1902, appropriated $600 to pay for plans and a

survey for a new municipal water system (The Spanish Fork Press, August 6, 1902), and the East Bench Irrigation and Manufacturing Company allocated money as well for a study of the possibilities of diverting Strawberry River water (Alexander 1971:289). The City and the East Bench Company hired Salt Lake City consulting engineer, Frank C. Kelsey, to accompany a committee to the Strawberry Valley for an initial examination on August 27 (The Spanish Fork Press, August 28, 1902). Among the members of this committee were Mayor Heber C. Jex, Mormon Stake President Henry Gardner, Alma C. Davis, and Richard Money of Spanish Fork, Al Money and A. W. Johnson of Palmyra, Eli Ferguson of Lake Shore, and Frank Davis from Salem--all towns that hoped to share in the "oceans of water" the project would bring (The Spanish Fork Press, September 4, 1902). In September, Kelsey made an initial report indicating the project could easily be accomplished by building two small dams, one across the Strawberry River and the other across Indian Creek. He calculated that the tunnel would have to be about 3.75 miles long to draw all the water from the reservoir into Diamond Fork Creek (The Spanish Fork Press, September 4, 1902). The Press noted, however, that the land would have to be "secured from the Government."

Local leaders had every reason to believe that the land could be "secured." A bill to allot the reservation`s northern portion containing the Strawberry Valley passed in May of 1902. The Reclamation Act gave the Interior Department the right to withdraw lands from the public domain for building reservoirs, and in all likelihood, the Strawberry Valley would be returned to the public domain as soon as the allotment process was complete. Jex, Gardner, and others decided to press their project at the Utah State Irrigation Congress scheduled for October 1-3, 1902 in Salt Lake. Newell would be there for the purpose of finding suitable projects for the new Reclamation Service, and the citizens of southern Utah Valley hoped to lure Reclamation funds away from other projects in the State.

There was a small celebration when Frederick Newell arrived in Salt Lake for the Utah State Irrigation Congress. The Salt Lake Commercial Club, and congress organizers met him at the train station, and escorted him to the club`s "elegant quarters" where Newell was treated to a "royal lunch" (Deseret News, October 1, 1902). As Director of the Reclamation Service, Newell gave the congress`s keynote speech, praising John Wesley Powell for realizing the possibilities of the arid West, and offering a detailed description of how the new Reclamation law would work. The following day was devoted to the presentation of a variety of reservoir projects, including a plan to develop all of the Bear River`s water, a plan to dike Utah Lake and lower the outlet so all the water could be used, a plan Newell favored to divert the Colorado River along the Book Cliffs, a series of dams on the Sevier River, and the Strawberry Valley Project. Newell pointed out that Utah would have a much better chance for success in securing Reclamation funds, if the Utah State Irrigation Congress could decide on one reservoir plan and lobby for it. Gardner and Jex argued forcefully for diverting Strawberry River water into

Utah Valley, not only to irrigate 50,000 acres in that area, but also because it would increase the flow into Utah Lake and the Salt Lake Valley (Deseret News, October 2, 1902; Salt Lake Tribune, October 3, 1902).

The congress appointed a special committee to review the proposed projects, decide on one, and put it before the congress for a vote the next day. The committee reported the following morning that they felt the diking of Utah Lake would provide more water to the State's most populous valley, and would offer the greatest potential for repaying the costs to the Reclamation Fund in 10 years. The committee also favored diverting the Strawberry River into Utah Valley, which would increase the flow into the Jordan River. This plan was unanimously adopted by the congress, and Newell expressed his satisfaction at the outcome. Twelve years previously, he had argued for the diking of Utah Lake in a USGS hydrographic survey report (USGS Annual Report, 1891). Newell and a delegation from Utah then took the plan to the National Irrigation Congress, held the next week in Colorado Springs, where it became part of a general request from that group for projects under the Reclamation Act. Immediately after the Utah State Irrigation Congress, citizens of southern Utah Valley held a mass meeting in Spanish Fork, and formed a permanent committee to "push the enterprise as fast as possible" (The Spanish Fork Press, October 3, 1902).

Despite this eager beginning, however, efforts to take advantage of the Federal Government's "generous offer" began to slow. In January 1903, the Utah State Legislature created the Arid Land Reclamation Fund Commission, as a vehicle for the State in dealing with the Reclamation Service. The commission held its first meeting in March and initiated a dialogue with Newell about the Utah Lake diking project. Newell, well informed as to the confused and disputed water rights on the Jordan River, replied that if those rights could be settled, the commission could expect prompt action from the Reclamation Service on the Utah Lake project. The commission hired an attorney, F.S. Richards, who was familiar with water rights on Utah Lake and the Jordan to help. Newell told the commission that he favored an association of water users that would be directly benefited by the project as a legal entity with which the Government could deal. In May 1903, Richards and the commission began trying to organize water users of Utah Lake, while Interior Secretary Hitchcock initiated the engineering surveys needed for the Utah Lake Project (Arid Lands Reclamation Fund Commission 1904).

The Strawberry Valley Committee pushed forward with its efforts as well during the first part of 1903. A letter was sent to Secretary Hitchcock asking for permission to enter the Uintah Reservation, file water locations, make surveys, and obtain the necessary data to apply for Reclamation Service authorization for that portion of the Utah Lake/Strawberry Valley Project endorsed by the Utah State Irrigation Congress (McKay 1982:76). USGS Director Charles Wolcott supported the request with Interior Secretary Hitchcock, saying "the amount of water to be used

for this enterprise will not interfere materially with irrigation of lands within the reservation" (Wolcott 1903). With the Department of Interior`s permission, the East Bench Irrigation and Manufacturing Company president, Henry Gardner, petitioned the Utah State Board of Land Commissioners for a portion of their reservoir land grant fund to conduct the Strawberry Valley surveys. Gardner succeeded in August in getting $1,500 to hire the engineering firm of Halen and Halen (The Spanish Fork Press, August 6, 1903).

Halen and Halen went into the field in early September and spent 2 months making extensive surveys. The surveys, however, alarmed the citizens of Vernal, who resented their water going over the divide into Salt Lake:

> There is a scheme on foot by which the people of Utah County propose to use the Strawberry Valley as a huge reservoir, to store the waters of the Strawberry River with which to irrigate the lands of Utah County.
>
> In view of the fact that there are thousands of acres of available land along the Strawberry and Duchesne Rivers which can be irrigated by this same water, and where it naturally belongs, we cannot help but admire the supreme affrontary with which our friends over the range set about appropriating something to which they have no moral right in the world...(Vernal Express, September 5, 1903).

Things were not going well either, with getting the contentious water users on the Jordan River to form an association:

> ...An attempt was made to induce the owners of land under Utah Lake to effect some form of organization that would enable them to deal with the Government in relation to the water supply. Much time was expended in an attempt to eliminate the many obstacles and objections that arose but this was never fully accomplished and it was feared that the Government would withdraw its men from the field and from the State (Arid Lands Reclamation Fund Commission 1904:8).

Furthermore, in March 1903, Congress passed an appropriations act to carry out the Uintah Indian Reservation Allotment Act of the previous year. President Roosevelt had objected to the 1902 bill because it did not set aside grazing lands for the Utes. When the 1903 bill emerged from Congress, it reserved 250,000 acres south of the Strawberry River for tribal grazing, a portion of which would have to be inundated if the Strawberry Reservoir was built as planned (MacKay 1982:82).

Fearful that the Utah project was falling apart, the Arid Lands Reclamation Fund Commission drew up another, more grandiose plan during the fall of 1903, and in January 1904, asked the

Reclamation Service to begin engineering studies. This plan was breathtaking in scope. Basically, it called for developing all the water of the Bear, Weber, Provo, and Duchesne Rivers to irrigate lands in Cache, Box Elder, Weber, Davis, Salt Lake, and Utah Valleys. The plan envisioned a huge dam on the Strawberry River filled by a canal that would begin 50 miles away and intercept at the 7,600-foot contour all the Duchesne River tributaries and drain the water into the reservoir. The Bear River portion of the plan called for a dam in Idaho, and the conversion of Bear Lake into a reservoir by diking. A canal would deliver Bear River water to Box Elder, Weber, Davis, and Salt Lake Valleys by running along the Wasatch front at the 4,500-foot contour. In addition, the Commission requested construction of "such dams on the Ogden, Weber, and Provo Rivers as may be necessary," the diking of Utah Lake and the Great Salt Lake, and the installation of "such channels as may be needed to properly distribute the same" (Arid Lands Reclamation Fund Commission 1904:14).

USGS Director Charles Wolcott replied on March 21, 1904 that the Reclamation Service would begin engineering surveys immediately, and urged the Commission to organize "the people interested." The Commission commenced an attempt to organize a Utah and Idaho Water Users Association, drew up Articles of Incorporation, and appointed one person in each county to begin contacting the 10,000 land owners involved.

The engineering investigations were divided into three sections for work during the summer and fall of 1904; Bear River, Utah Lake, and Duchesne River/Strawberry Valley. By December, the studies on the Bear River and Utah Lake had almost eliminated these two proposals. George L. Swendsen, Reclamation Service District Engineer for Utah, described the reasons for eliminating these parts of the Arid Lands Reclamation Fund Commission's proposal in the 1905 Reclamation Service Annual Report:

> When all problems with the Utah Lake Project were considered, it was doubtful if it was feasible under the requirements of the Reclamation Service. The great area of the lake makes it an extremely inefficient reservoir, as about two-thirds of all water reaching the lake is lost by evaporation. The use of the flood waters of streams tributary to the lake for irrigation is increasing from year to year, and when such beneficial use is considered it would seem that a court might decide such claims to supersede the right to have the waters flow into the lake to supply the evaporation from the reservoir. In the entire history of the project, it has not appeared that there was any substantial effort on the part of the owners of existing canals to form a water users' association to further the project.

The Bear River proposal suffered from a similar defect, in that existing water rights in three States--Idaho, Wyoming, and Utah--would be difficult to incorporate into a massive project to

divert spring flood waters south to Salt Lake Valley. In addition, Swendsen pointed out "a great deal of very expensive construction would be necessary before any benefits would result" (Reclamation Service 1906).

During the fall of 1904, Swendsen sent E. F. Tabor into the Uintah Basin to study the Arid Land Reclamation Fund Commission's request for diverting other tributaries of the Duchesne River into the reservoir. After following several lines along the south slope of the Uinta Mountains for the Commission's "50-mile canal," Tabor found, however, that its actual length would be 150 miles, and concluded:

> Beyond a doubt, the reinforcement of the Strawberry from the streams farther east is not practicable. Were the canal constructed, its operation in the spring when the flood should be delivered into the reservoir, would be extremely difficult where 150 miles of mountain channel was concerned. Furthermore, the construction of an aqueduct involving 7,000,000 yards of mountain material in open cut and 2,000,000 yards in tunnel in a minimum possibility is beyond the consideration when compared with the benefits to be derived...In view of this, the only possibility within the entire project is the utilization of the supply from the Strawberry aone (Reclamation Service 1905:513).

The Strawberry Valley Project as originally proposed by Gardner, Jex, and the others--two small dams on Strawberry River, a 19,500-foot tunnel, and use and expansion of the existing distribution system--had become the leading project by the end of 1904. Tabor had investigated the Spanish Fork River Canals during the summer of 1904, and had concluded that with some improvement, and with the construction of one or two new canals, the existing distribution system was adequate for the increased water supply. George Swendsen began actively compaigning for the Strawberry Valley proposal within the Reclamation Service, and set in motion the actions needed to withdraw the land for further study before the opening of the reservation.

In August, Swendsen wrote a letter to Henry Gardner and the Strawberry Valley Committee urging him to organize the canal companies into a water users association, and sketching out the preliminary results of Tabor's survey:

> In relation to the development of the Strawberry Valley Project, I beg to say that careful consideration of the conditions show that to fix up the entire situation the cost will come within the limits prescribed, viz: $40 per acre. There was signed 26,210 acres which at $40 per acre will amount to $1,048,400. Our estimate exclusive of maintenance is about $1,000,000 as you know and we have put the maintenance averaging 50 cents
>
> per year per acre which we think is reasonable and

per year per acre which we think is reasonable and sufficient.

Our estimates have included such canal improvements as seem necessary and the cost, as you are aware, exclusive of maintenance, is about $1,000,000 and includes such new canals and fixing up and enlarging of old canals as is necessary to properly distribute the water now available and that to be developed. The notion that retification of existing systems is not included is wrong.

We have not included lateral ditches, having the understanding that the water users would take care of these.

You may therefore say to your people that our estimate of about $1,000,000, exclusive of maintenance for 10 years estimated at 50 cents per acre per year, includes the cost of getting the water from Strawberry and putting in operation all main canals for distributing the water over the entire area including that now irrigated, meaning of course, to improve and enlarge existing canals where found advisable.

Now you will remember that the department has suggested and will insist upon a unification of existing water, canals, etc. with the Association. That is, every man in the district will have his water manipulated by the Association. This is an absolute necessity. The Project can go on no other basis.

Then if Charles Hanks, the first signer of the original petition has water sufficient for 20 acres, say in the Salem Canal and wishes water for 35 acres from the new developments, he will surrender his 20 acres, under priority reservation if he thinks it necessary, to the Association and subscribe for 55 acres, giving the Association his entire 55 acres of land as security. This is an individual security and he is in no wise responsible for his neighbor`s bill, and in the matter of security, it can be no difference to him if he gives 100 acres to secure $100 of the new water right.

His contract will be with the Association of which he is a member, the Association making a general contract with the Secretary of the Interior.

The Government will, of necessity, know all men and all acres alike in matter of cost per acre, that is there will be about 50,000 acres in the project as a whole and suppose we say that the average cost of all improvement over the entire area amounts to $25 per acre, the Department would know Charles Hanks as a stockholder in the Association for 55 acres. Hanks may

> pay the Association, say $40 for 35 acres and nothing for the 20, merely transferring the supervision of water, or in case the System now delivering the 20 acres water needs some rectification, his proportion of that cost should certainly be met by him. The adjustments of this can certainly be made equitably.

In the 1904 Indian Appropriations Act, Congress set March 10, 1905 as the date by which all the Utes would have received allotments and the Reservation would be open to White settlement. In the fall of 1904, Uintah Reservation Indian Agent C. H. Hall requested that the Ute's proposed grazing reserve be moved to the Deep Creek area "as that portion of the reservation south of the Strawberry is not the best, and is only suitable for a winter range" (MacKay 1982:83). On December 9, George Swendsen wrote a letter to Gifford Pinchot, head of the U.S. Forest Service, which discussed the Strawberry Valley Project and inquired about Pinchot's efforts to have portions of the reservation included in the Uinta National Forest. Swendsen then followed up with a December 22nd letter to Newell, seeking his help with the Forest Service, and with securing Congress's approval for setting the lands apart for a reservoir site:

> This is a very nice piece of grazing country, and will be taken up very quickly by settlers as soon as the Reservation is opened unless we can secure it in some way (MacKay 1982:94).

Senator Reed Smoot of Provo was quite active in supporting the Strawberry Valley Project in Congress. When a bill delaying the Reservation opening from March 1905 until September passed Congress, Smoot succeeded in having language inserted that gave President Theodore Roosevelt the right to set apart a reservoir site, which Roosevelt did on August 14, 1905. Throughout 1905, Smoot traveled among the little Utah County towns that would benefit from the Project, and urged the people to cooperate:

> A big mass meeting was held at the pavilion yesterday of the water users of the southern part of the county (April 26, 1905). Senator Smoot was present and delivered a stirring address, explaining what the Government intended to do in the near future. The meeting was called for the purpose of getting the stockholders of the different irrigation companies to unite on the proposition and work together in bringing the Strawberry water into this valley (The Spanish Fork Press, April 27, 1905).

With 92 percent of the land included in the Project proposal in private hands, the Reclamation Service feared that Strawberry Valley Project would fail because water rights would prove as difficult to settle as those on the Jordan River.

In January, 1905, 1,162 residents of southern Utah Valley had signed a petition asking the Reclamation Service to conduct

the necessary surveys "to a point where estimates of cost can be given us." The petition declared the willingness of local water users to pay up to $40 per acre, and to transfer ownership of their lands and water rights to a Water Users Association as collateral for the Government loan. On February 1, 1905, the five major Spanish Fork River canals began taking applications for water from local farmers for the Strawberry Valley Project to determine if all the water would be used (The Spanish Fork Press, February 2, 1905). By June 21, the irrigation companies had received applications for 50,000 acre-feet and on that date joined together to incorporate as the Strawberry Water Users Association. Stake President Henry Gardner was elected president of the new association. The contract by which old water rights and land titles were subsumed under the new association as security for construction costs followed closely contracts signed by private landholders under other Federal projects. It guaranteed the continued ownership of existing water and land titles under the new association, and returned those titles to the owner should the project fail to materialize (The Spanish Fork Press, June 22, 1905; Reclamation Service 1905:333).

On September 8, 1905, Charles Wolcott, Director of the USGS, wrote to the Secretary of the Interior indicating that a board of engineers had found the Strawberry Valley Project feasible and asked permission to announce to the Water Users Association:

> that as soon as the people have made the proper adjustment of water rights and guaranteed the return of the Reclamation Fund in a manner acceptable to the Department. construction on the system will be promptly undertaken (U.S. Bureau of Reclamation 1949).

The estimate quoted in this letter for the Project was now $1.25 million, but Wolcott noted that "this may be increased owing to the uncertainities of estimates in a long tunnel" (U.S. Bureau of Reclamation 1949:528). A month later, the Reclamation Service Board of Consulting Engineers wrote to the Secretary of the Interior as well, offering their support for Strawberry Valley:

> A meeting of the prominent land and water owners concerned in the project was held at Spanish Fork October first which we attended, where many questions of policy and law were discussed by Mr. Bien (The Reclamation Service attorney)...We find that nearly nine-tenths of the land holdings concerned have been pledged to the support of the proposition, and it is the aim and determination of the people to secure a very thorough cooperation of all the water rights in the district...It is probable that within a very short time all the owners of land will have signed proper agreements, and the Government will be justified in taking up the construction (U.S. Bureau of Reclamation 1949:529).

The Board of Engineers also made an estimate of the money available from the Reclamation Fund for construction and discovered that in the most recent estimate of the Fund's size in future years, "no account was taken of prospective returns from irrigated lands under the provisions of the Act." The Board estimated that by 1908, the initial repayments from existing projects would be $2 million a year.

On December 15, 1905, Secretary Hitchcock, in a letter to Wolcott, authorized the Strawberry Valley Project under the following three conditions:

(1) His authorization was based on the complete settling of existing water rights.

(2) The Project would cost no more than $1.25 million.

(3) The estimate of the amount of money that would be repaid to the fund made by the Board of Engineers was accurate (U.S. Bureau of Reclamation 1949:531).

Several factors combined to foster this authorization and made the Strawberry Valley Project emerge successfully from the welter of competing proposals. First, and foremost, was the ability of southern Utah Valley water users to cooperate in settling the water rights question. There was a widespread feeling that the 1899 District Court decree had established the rights permanently and as long as these rights were guaranteed under the Strawberry Project, there was little local contention as to the amount of Strawberry water that should go to any individual land holder. The role of Henry Gardner in organizing local water users indicates the Mormon Church's de facto role in this cooperative effort. As president of the Nebo Stake, and president of the Commercial Bank, and State Senator, and finally president of the Strawberry Water Users Association, Gardner was in a unique position in the community, one that allowed him to draw on both his religious and secular authority to urge cooperation. Later, during the construction, Gardner called out members of the Water Users Association to donate their labor toward building a road to the construction site in a move reminiscent of the Church's role during the 19th century in organizing cooperative community construction of irrigation works. Second, the opening of the Uintah Reservation with its large supply of unappropriated water, happened to coincide with the creation of the Reclamation Service which made the appropriation of the water, and the reserving of the reservoir site possible. Finally, the Strawberry Valley Project was a smaller, simpler project, and except for the tunnel, required only simple engineering and construction technology. Although the original cost estimate eventually landed far short of the mark, the relatively simple plan made the likelihood of its completion, and the eventual return of the money to the Reclamation Fund, much more likely.

VI. STRAWBERRY VALLEY PROJECT--CONSTRUCTION

Although the Project had been authorized by the Secretary of the Interior and a Strawberry Water Users Association formed, Frederick Newell was still worried about the havoc a water rights dispute could wreak with the Project. In January 1906, he asked the Utah District Office to prepare a detailed report covering "all matters relating to possible conflicts in water rights, the status of stock subscriptions, and any complications that might be expected in the future" (Swendsen 1907:3).

Engineer A. E. Chandler was immediately assigned to investigate and prepare the report. Chandler began by verifying the appropriation rights on the Spanish Fork and Duchesne River Systems, and ascertained that the Utah State Engineer had approved just that month the application made on January 27, 1904 to appropriate Strawberry River water for storage in the proposed reservoir. Chandler noted that the three ditches built by Heber Valley farmers would be allowed to continue to divert small amounts of water:

> The only vested water rights in the Strawberry River basin above the proposed reservoir are for three ditches for irrigating land in Heber Valley. These ditches were constructed and operated without authority from the Indian Office or the Interior Department. In 1905, the Indian Agent in charge proposed to prevent further diversion through the three ditches. The case was appealed to the Interior Department, and upon the recommendation of Mr. Code, the owners have been allowed to clean out their ditches but not to enlarge them beyond their original capacity...District Engineer Swendsen states that the total amount of water diverted and used beneficially cannot exceed 3490 acre feet per year. This amount being so small that the Project is in no way endangered by the three ditches. The State Engineer will not allow enlargements of these ditches to be made (Chandler 1906:4).

Other rights had been filed on the Duchesne River for the Utes by C. G. Hall, a member of the allotting commission for the Uintah Indian Reservation. Hall had appropriated 210 of the 271 second-foot yearly flow of the river 2 years after the appropriation for the Strawberry Water Users Association had been filed, and Chandler concluded that Hall's filings would not interfere with the Project. In addition, settlers entering the Reservation after August 28, 1905 had filed for water from the Duchesne River, and protested the Strawberry River appropriation, but the State Engineer refused to grant their appropriations. Chandler concluded that the "government has a perfect right to store the runoff of Strawberry River and Indian Creek in the proposed reservoir."

There was little cause for concern over rights for the Spanish Fork River and Payson Creek waters. Since the decree in 1899, there had been no litigation over water rights to the Spanish Fork River, and Payson Creek's water rights had been similarly settled by judicial decree in March 1904. Chandler noted that Utah had even passed a law in 1905 which guaranteed a legal right to turn appropriated, reservoir water into the natural channel of a creek and recover it downstream, exactly as the Reclamation Service proposed to do in Diamond Fork Creek.

Chandler investigated two other important matters, the availability of rights-of-way for Project canals, and the adequacy of the amount of land subscribed to the Project to pay for the cost. The rights-of-way issue had been simply settled by having every farmer who signed a contract with the Strawberry Water Users Association guarantee to grant a right-of-way for Project structures. All of the proposed canal locations, investigated the year before, were on lands subscribed to by the Water Users Association. By January 1906, 53,000 acres had been subscribed in the Water Users Association or 93 percent of the total area that could possibly be reached by the proposed canal/lateral system, more than enough to fully utilize the water fully that the Reclamation Service expected to provide from the Project.

Chandler pointed out the only remaining problem, one which would later disrupt relations between the Reclamation Service and the Water Users Association. The costs of the Project, and the repayment contracts, would be based on the amount of water used, with land owners having existing partial rights from the Spanish Fork River only paying for the supplementary supply. Although Chandler believed that the "adjustment will be a minor difficulty," the issue eventually proved much harder to settle.

A board of engineers met in Salt Lake on February 26, and concurred with A. E. Chandler's report. They recommended to Newell that the Reclamation Service enter into a contract with the Strawberry Water Users Association for construction. After the Reclamation Service's legal department had made one final review of the existing stock subscriptions, the Secretary of the Interior signed a contract on March 6, 1906, and construction began (Swendsen 1907:4-10).

During this final review, Reclamation engineers had begun the tunnel drawings that would be needed to start construction. The construction plan called for beginning the tunnel immediately, as it would take by far the longest time to complete. During the summer of 1906, several preparatory projects were begun. President Henry Gardner organized the Water Users Association to donate their labor for construction of a road up Diamond Fork Canyon from the siding that The Denver and Rio Grande Western was building at the mouth of Diamond Fork Canyon. The road crossed Diamond Fork Creek at several points along its route, and the Water Users Association built several

bridges designed to carry heavy loads of freight. A small parcel of land adjacent to the railroad siding was leased from Henry Gardner, and a stable and corral, a house, and a platform tent were erected to serve as a supply depot for the Project.

Originally, Project Engineer George Swendsen intended to have the tunnel built under contract by a construction company. As soon as the water users had finished enough of the road to allow access to the west tunnel portal site, Swendsen asked for bids on August 30th, but received none. The Reclamation Service then decided to proceed with the construction on its own. On September 14, excavation of the tunnel began with electric drills powered a by gasoline-fueled generator. These drills, however, were unreliable, and the frequent breakdowns and delays cost the Project time and money. "It is sufficient to say," Swendsen noted, "that these drills did not give satisfaction" (Strawberry Valley Project Annual History 1906:3). As the tunnel deepened, a ventilation system was installed. The soft earth in the tunnel`s early section required extensive timbering to prevent cave-ins.

Lumber for tunnel timbers and for the construction camp rapidly going up on a meadow just east of the portal was ordered from Henry Gardner`s sawmill near the proposed reservoir site. The camp included a mercantile store, hospital, cabins, a Project office and powder house. During the summer and fall of 1906, Mr. E. A. Hess of Iowa was hired to build a telephone line from Spanish Fork to the east and west portals of the tunnel. The Diamond Fork road was finished in September, and the Project Office in Provo rushed supplies to the west portal camp before the heavy snows came. Work was continued through the winter. Swendsen was increasingly dissatisfied with the tunnel`s progress. The Reclamation Fund was almost gone, and the slow tunnel work was costing a good deal more than anticipated. After studying the situation, Swendsen proposed that a hydroelectric plant be built to power a newer and more efficient drill and to provide cheaper electricity for a variety of purposes. On December 4, 1906, Newell authorized the construction of the Spanish Fork Diversion Structure, a power canal, and hydroelectric generator.

By July 1907, the lack of funds and the high cost of the tunnel work forced the Reclamation Service to halt work and push for the completion of the power canal and plant. In the first year, only 1,567 feet had been dug. At that rate, it would have taken over 12 years to complete the tunnel. During the spring and summer of 1907, designs were drafted of the diversion structure, power canal, and powerhouse. Survey crews also marked a route for an electric transmission line to the west portal.

Construction of the Spanish Fork Diversion Structure began May 1, 1907 and continued until October, when

early winter weather halted work. The plans called for a concrete diversion structure on the Spanish Fork river 16 feet high and 70 feet long with two settling basins for taking out the silt a 3.3-mile power canal (Figures 13-16), and a pressure pipe at the southern end leading to the Powerhouse. The Reclamation Service purchased the electrical equipment for $26,000 from General Electric and the turbine blades from Dayton Globe Iron Works for $12,500.

The Powerhouse contained two 450 KW generators and two 600 horsepower turbines. During the spring of 1908, the Reclamation Service designed a high-voltage transmission line to the west portal construction site, and in March secured the rights-of-way and began placing poles and stringing wire. By September, the line was finished, and a substation was installed at the west portal. On December 13, 1908, water was turned into the Power Canal and the generators began producing electricity. In the spring of 1909, various improvements were made to the power system. A gatekeeper's house was built at the Spanish Fork diversion Structure and a residence and outbuildings were erected near the Powerhouse.

With the hydroelectric plant almost finished (Figure 26), work resumed again on the tunnel on October 1, 1908, initially using the old drills and equipment. When hydroelectric power became available in December, crews installed electric hoists and an electric tram and began using more powerful drills for removing rock from the tunnel. (See Figure 28.) The tunnel's length grew rapidly. By the end of 1909, 5,505 feet had been excavated (29 percent of the length), and a year later the tunnel had been drilled 10,536 feet (55 percent of the length).

With half the excavation of the tunnel complete, plans for lining the tunnel with concrete got underway. During April, a crushing and mixing plant for the cement was designed, along with steel forms for holding the wet cement in place. Project engineers then initiated the building of the plant during the summer on a flat area just below the tunnel mouth. Some of the machinery for the cement plant was transferred from the Salt River Project. A rock quarry was opened 500 feet away, and in October 1910, lining of the tunnel began.

As Figure 27 shows, there was little water encountered in excavating the first sections of the tunnel. On December 28, 1910, crews struck an underground stream producing about 6 to 7 second-feet of water. From then on, workmen wore hip boots and raincoats, but still most left the tunnel thoroughly soaked after the shift. The Reclamation Service had to pay a bonus to keep men on the job. During the next year, the water would impede tunnel progress 30 percent, and push up construction costs much farther than anticipated.

By the end of 1910, it was becoming evident that the Reclamation Service had over-extended itself financially. The Strawberry Valley Project, originally estimated at $1.25 million had already reached that figure. The tunnel excavation was only half complete, the dam had not even been begun, and the canals and laterals were not yet off the drawing board. The hydroelectric system had cost $450,000 to build to which had been added another $150,000 in building construction camps, a telephone line, roads, and buying rights-of-ways. By this time, it looked as though it was going to cost over a million dollars just to complete the tunnel excavation, exclusive of the concrete lining, meaning the total promised to be well over $3 million just to get the reservoir/tunnel system built and working.

In addition to the construction cost overruns, the Indian Agent for the Utes began asking for lease money for the Strawberry Valley. Although the land had been withdrawn from entry, the title still rested in the hands of the Utes. Of the 60,000 acres withdrawn, Reclamation engineers expected that a little over 8,000 would be inundated, and the other 51,840 acres of watershed area would be subsequently leased for grazing. The Ute claim to the grazing lease money was contested by the Strawberry Water Users Association who felt that the money should go to help repay part of the construction costs, now almost triple original estimates. The Water Users Association asked Utah Senator Sutherland to push a measure through Congress that would allow the Reclamation Service to purchase the grazing land as part of the Project`s construction cost. Sutherland introduced the first bill in February 1910 with a price of $1.25 an acre, but it failed to pass. Sutherland managed to have it attached to the Fiscal Year 1911 Indian Appropriations Act 2 months later, however, and the Utes were eventually paid $71,000 for the land (MacKay 1982:87).

The Reclamation Service was experiencing budget problems on most of its projects throughout the West. By 1910, Western Congressmen were seeking a way to secure funds from the Treasury to complete the existing projects. Congress eventually agreed to provide $20 million to the Reclamation Service by authorizing the Treasury to sell bonds. The Service would have to begin repaying the bonds in 1915 from the proceeds from the sale of public lands and the funds returned by functioning projects to cover construction costs (Thomas 1920:254). A Board of Army Engineers was required, however, to review the feasibility of all of the Services existing projects, and then make an estimate of the cost to complete them. In October 1910, the Army Engineers visited the Strawberry Valley Project and recommended $2,272,000 of the Treasury`s bond issue be allotted to complete the Project, bringing the Strawberry`s final construction cost estimate to $3.5 million.

With the money to finish the Project now in hand, the Reclamation Service pressed forward with plans and drawings for the Strawberry River Dam, Indian Creek Dike,

and the diversion structures for Indian and Trail Hollow creeks. During the spring of 1911, Project engineers studied various dam types and the possibility of increased storage in Strawberry Valley. Since the early planning phases of the Project 6 years earlier, accurate records of runoff from the Strawberry River, Indian Creek, and Trail Hollow Creek had been kept. In years of high water, Strawberry River alone produced almost 125,000 acre feet. Clearly the original dam proposal (45 feet high and 325 long) for a reservoir of 100,000 acre-feet was not large enough to store the water appropriated for the Project. Engineers decided that it would be much better to put a low dike across the saddle between Indian Creek and the Strawberry River, and increase the dam to 72 feet high and 490 feet long which would create a reservoir capable of holding 283,000 acre-feet. In addition to the water of the Strawberry River, engineers designed 6 miles of ancillary canals to divert Indian and Trail Hollow Creeks directly into the reservoir (Strawberry Valley Project Annual History 1911).

Serious planning began as well on the Project`s distribution system. During the summer of 1910, the Service launched a series of experiments in southern Utah Valley to determine how much water would be needed to grow various crops at different locations and in different soils. Test plots, established at several locations throughout the valley, received measured amounts of water. Growth rates, drainage, and yields were recorded. In addition to these investigations, Project engineers began studying the existing Spanish Fork River canals in 1911 to see which of them would need improvement and which could be extended to carry the stored water into new areas. Considerable work was done as well on the route of the High Line Canal, the only major distribution feature constructed entirely by the Reclamation Service (Strawberry Valley Project Annual History 1911). Survey crews mapped a route for the High Line Canal during the summer of 1911 from the diversion works at the end of the Power Canal all the way to West Mountain. The Service then began securing the rights-of-way, and by the end of the year had them finalized to Payson.

Prior to initiating construction of the dam, dike, and diversion structures, the Reclamation Service installed the infrastructure for the work. Since 1909, the power plant had provided electricity to both the Project and to local residents in Spanish Fork City. Now transmission lines were extended to Payson City and to construction sites at the tunnel`s east portal, Indian Creek Dike, and Strawberry River Dam. New roads and a telephone line were built as well from east portal to Indian Creek Dike, and the Strawberry Dam site.

With everything ready, construction on the reservoir features began almost immediately. The Service built the Strawberry Dam, and contracted with W. O. Morrison Construction Company of Denver for the Indian Creek Dike, and Ely Construction Company of Springville for the Indian Creek Canal and Trail Hollow Creek Canal.

On June 18, 1911 crews began clearing brush, loose rock and topsoil from the Strawberry Dam site. Using a small dam across the river, engineers diverted the Strawberry River into a sluicing tunnel that looped around the north end of the dam site.

The Strawberry Dam and Indian Creek Dike have almost identical designs. In the center of each dam is a concrete "corewall," embedded into the rock below the dam. On either side of the corewall is a huge pile of soil and gravel. The upstream side slope of the dam rises 1 vertical foot for every 3 horizontally, and the downstream side slope rises 1 vertical foot for every 2 feet. The upstream slope was "paved" by masons with 1-foot sandstone blocks, and the downstream side was seeded. On the downstream side of the corewall in each dam, was a system of drains and gutters which guided seepage from the interior of the dam back to the original stream channel to prevent erosion damage.

Excavation for the Strawberry Dam`s corewall foundation began in late June 1911 and continued through November.

A crushing and mixing plant from the Reclamation Service`s Salt River Arizona Project was transported to the area in August and erected on a hillside south of the dam site. Rock from a quarry on the north side and the finished cement were transported by a cableway, supported by a derrick on either side of the river channel. On September 14, a horsedrawn wagon placed the first load of earthfill on the dam, and by December 10 when work shut down for the winter, thousands of wagonloads had been placed. During the first season, the dam had grown to 25 feet high on the upstream side, and 17 feet on the downstream side.

Construction Engineer F. W. Carter, concerned over the cracked and broken rock surrounding the footing for the corewall, asked for a Board of Reclamation engineers to review the excavation`s progress:

> As the work of excavating the corewall trench progressed, it was found that the material continued to be a blocky limestone badly broken up, containing occasional streaks of water-bearing disintegrated limestone and clay. Water spouted from drill holes in the bottom of the trench from time to time, indicating that the water in the seams was under considerable pressure. Mr. W. H. Sanders was called into consult and recommended that the trench be put down still deeper, which was done (Strawberry Valley Project Annual History 1911:2).

On November 15, a Board of Reclamation engineers inspected the trench, found it deep enough to be secure, and approved the start of the concrete work.

Work began on three other parts of the Project during the fall of 1911--Indian Creek Dike, the tunnel's east portal, and the Indian Creek and Trail Hollow Creek canals.

Morrison Construction Co. built its camp near the Indian Creek Dike location in mid-July, and immediately began excavation on the Dike's corewall trench. All excavation was done with pick and shovel. About 6 feet down, crews in the trench hit water, and a little farther down struck a huge pit of quicksand, which eventually proved to be 220 feet long and 11 feet deep. Morrison decided to support that section of the corewall on wooden pilings. Using a set of rock crusher's "jaws" strapped together and a team of hourses for a pile driver, "Wakefield Sheet Piling" was driven down to bedrock, and planks were secured along both sides of the trench. The quicksand delayed the scheduled construction for most of 1911, but by the time the camp was shut down in late October, most of the 1,116-foot corewall trench had been dug and a portion of the concrete laid.

Construction of the earth embankment on either side of the corewall followed closely the plan used by the Reclamation Service in building the Strawberry Dam. The site was first prepared by stripping off the brush and a layer of topsoil. Morrison then ran plows over the area to roughen the surface. Earthfill was carried from two major borrow areas south of the dike by horse and wagon teams, which averaged "1.6 cubic yards per load" (W. O. Morrison 1913). The embankment grew in a series of 6-inch layers. Between each layer, a 4-ton roller compacted the dirt. Workmen then wet the surface in preparation for the next layer. On the downstream side, a system of 8-inch drains carried seepage away from the corewall to a drainage channel. By the end of the construction season on October 27, 1911, about 25 percent of the earthwork had been completed.

In September 1911, Ely Construction Company of Springville, Utah began work on the 6 miles of canals that would divert Indian and Trail Hollow creeks directly into the reservoir. The plan called for intercepting Trail Hollow Creek with a small earth dam, diverting it through a concrete "intake" structure into a 4-mile canal with a 125-second foot capacity. The Trail Hollow Canal empties into a small catch basin created by a similar earth dam across Indian Creek. The water from both creeks is then diverted through another "intake" structure into the Indian Creek Canal, which has a capacity of 600 second feet and is 2 miles long. Just before the Indian Creek Canal reaches the reservoir, it crosses Horse Creek. By means of another small dam, the Indian Creek Canal picks up the Horse Creek flow and carries it into the reservoir. At the end of the Indian Creek Canal is a "weir" or measuring device and a "terminal chute."

Ely Construction immediately subcontracted the majority of the 1911 canal digging to a variety of smaller, local contrac-

tors. The work went slowly for 2 months until temperatures dropped, and the ground became too frozen to work. The Service Engineer in charge of the canal work, O. G. Patch, was unhappy with the quality of the subcontractors Ely construction had selected. He placed a part of the blame on Ely, but also on the tight labor market that had developed as a result of so much construction activity:

> Very poor management was shown on the part of the main contractor, as the subcontractors were allowed to pick out the best sections of the work on Trail Hollow Canal and to do only the best parts of that work, leaving the most difficult and uncertain work on Indian Creek Canal until the last. While the subcontractors were for the most part willing to do satisfactory work, they were all apparently unfamiliar with canal work, and were totally unfamiliar with the specifications and requirements therein. In fact, the superintendent in charge for the main.contractor was not himself familiar enough with the specifications, that he often, unintentionally mislead the subcontractors in regards to what they could expect. On this account the work at all times required very close inspection, and especially when a new contractor began work. It was often necessary to detail one of the engineering party to "stay by them" for several days to get the work started properly (Patch 1912:17).

In addition to launching construction of the Indian Creek and Trail Hollow Canals in September 1911, the Reclamation Service also began work on the east portal of the tunnel. After a camp and office buildings had been built, the Service erected a large "drag line" or excavator and started digging a channel down to the point where the eastern end of the tunnnel would have to enter bedrock. The concrete forms for the tunnel were laid right in this channel. Construction conditions were somewhat more primitive at the east portal. Water draining down into the tunnel heading had to be pumped out, and excavated rock and mud were hauled out by mule-drawn cars. Despite these disadvantages, over 500 feet of tunnel were dug before the end of 1911.

Excellent progress had been made in 1911 towards finishing the reservoir and tunnel. Reclamation Service Project Engineer James Lytel fully expected to finish construction in 1912, but spring came late to the Strawberry Valley that year. Most of the contractors did not begin work until June 1. Only the crews paid directly by the Service began earlier in the year. In April, the shaft for the "controlling works" at the east portal was begun. These works control release of the reservoir water into the tunnel.

As in years past, work on the tunnel had continued through the winter. By the spring of 1912, excavation pushed ahead rapidly with three shifts working from each portal. Engineers

accurately calculated that the two headings would meet sometime in late June. At 7 am, June 20, 1912, one of the Sullivan Air Drills broke through the rock separating the east and west headings. The survey work had been so accurate that the two shafts were just slightly more than 2 inches off over the 19,091-foot length of the tunnel. Most of the work force then turned to finishing the concrete tunnel lining. Both the Reclamation Service and W. O. Morrison construction followed a similar system for completing the Strawberry Dam and Indian Creek Dike during the summer and fall of 1912. Plans called for "paving" the upstream side of both structures with a layer of carefully-laid stone. With about half of the earth embankment placed during the 1911 season, masons began fitting the stone from the "toe" of each structure, and followed the progress of the earthwork to the top. Morrison set up its own quarry and crusher 1 1/2 miles to the east, and rock not suitable for the paving was crushed into gravel to be placed in a layer between the earth embankment and the paving. The company employed an average of 10 masons between June and November 1912 just to finish the work on time. Morrison calculated that the masonry work alone totaled 30 percent of the Indian Creek Dike's cost ($115,000).

The weather did favor construction efforts during the summer and fall of 1912, and work on Indian Creek Dike proceeded rapidly. By the first week in September, the earth embankment was complete. Morrison then covered the "downstream" surface with the topsoil scraped the year before from the dike site and seeded the surface with "one hundred pounds of good blue grass seed" (W. O. Morrison 1913). Specifications called for a paved berm filled with crushed rock to serve as a roadway on top of the dike. The work drew to a close by the middle of October 1912 when masons completed the upstream paving all the way to the berm. Morrison then filled the top with crushed rock and gravel, with the last load being laid on October 10, 1912.

Filling of the reservoir actually began prior to finishing the Strawberry Dam. As with Indian Creek Dike, masons hired by the Reclamation Service began laying the paving stone in the beginning of June 1912 and followed the earthwork to the top. The sluiceway, through which the Strawberry River had been diverted, was lined with concrete, and gates were installed during June. On July 14, 1912 Project Engineer James Lytel closed the sluiceway gate, and the Strawberry River began filling the reservoir. Two months later, on September 17, the last wagonload of dirt was placed and rolled onto the dam. Masons continued to work on the paving until October 29th and had just finished when the weather turned too cold to work. All that remained to be done during the following year was the completion of the spillway on the north side of the dam.

When construction crews finished laying the Strawberry Dam's earth embankment on September 17th, they were immediately trans-

ferred to help Ely Construction finish the Trail Hollow and Indian Creek canals. The Reclamation Service hired W. O. Morrison to build the concrete structures for this canal system, as well as a number of bridges over the canals.
As Assistant Project Engineer O. G. Patch put it, Ely was delayed "on account of labor conditions, bad weather, and poor management" (Strawberry Valley Project Annual History 1913:7). Work on the canals went slowly through the summer and fall of 1912. Occasionally, the ground through which the canals were being dug was too moist to form for the banks, and material had to be borrowed from the higher, drier areas. The dam and intake structure for Trail Hollow Creek were completed September 30, 1912, and the water was turned into the canal on November 5.

> There was just about 2 second feet running (Trail Hollow Creek). It went nearly a mile the first 24 hours, but found some porous ground at about Station 30 on the second day, and did not get far past that place. It was left running for two weeks and then turned off for the winter thru the sluiceway at the Intake (W. O. Morrison 1913:13).

The Indian Creek dam, intake structure, and canal were somewhat larger, and the canal work, particularly through the wet ground near Horse Creek was difficult and the excavation very slow. The Indian Creek "terminal chute" a "notched weir" to measure the water entering the reservoir and two bridges (Figures 60 and 61), were subcontracted to Midwest Engineering of Omaha, Nebraska. Midwest finished the chute and weir on September 20. It was not until November 5th, however, that the main concrete contractor finished the Indian Creek dam and intake, and the canal itself was not complete until November 18th. On the 19th, Reclamation Service Assistant Engineer O. G. Patch turned the water over two weirs at the Indian Creek Intake. The water took 24 hours to reach the weir and terminal chute at the end of the canal.

The only work scheduled for 1912 on the Strawberry Valley Project diversion and storage system that remained unfinished was some minor concrete work on the tunnel. Reclamation Service crews had been lining the tunnel since July 1911, by laying the bottom of the lining and then the sides and arched top. While workmen finished the tunnel lining and intake structure near the east portal, a "suitable portal structure" and weir were erected at the west portal during November. By the middle of December, concrete work on the east portal intake structure and tunnel lining was finished. On December 17th, crews removed the track and electric lines from the tunnel.

Except for some minor construction work, the majority of the Strawberry Valley Project collection and storage facilities was ready for use by the end of 1912. Excavation of the dam spillway and the erection of a concrete bridge over it started as soon as

weather cleared in June 1913, and ended on September 20th. All of the camp buildings and the crushing and mixing plant were torn down and hauled to Diamond Switch. Some of the machinery was moved to other Reclamation Service projects, and most of the lumber was sold for scrap. The Trail Hollow/Indian Creek collection system received some finishing touches, with the addition of more fill to the Indian Creek dam, and the installation of some metal gates on the Indian Creek intake structure weirs. A gatekeeper's cottage and a housing for the east portal intake works were built. At the west portal, the Service dug a "stilling basin" between the portal and the weir. On September 13, 1913, the first water was released from the reservior into the tunnel, and the Project officially opened.

With the reservoir filling and the construction work almost finished during the winter of 1912-13, disputes arose in earnest between three factions within the Strawberry Water Users Association over how construction costs would be repaid. Reclamation Service Director Frederick Newell sent a letter to the Association on October 10, 1912 asking them to formulate a plan for repaying Project costs within the 10 years stipulated in the law. In return, Newell received on January 17, 1913 three petitions--one from Payson water users, one from Mapleton water users, and one from the group of original five canals taking water from the Spanish Fork River.

The Spanish Fork River water users were in an enviable position. With the dam and tunnel complete, they could take advantage of the extra water supply without further construction. All the Service would have to do is release water into the river for these canals. Naturally, the Spanish Fork River water users were not interested in sharing the cost of building the High Line Canal and Mapleton Lateral. Their petition requested that those water users needing further construction should bear that burden by themselves. Mapleton and Payson water users requested just the opposite, of course. They wanted immediate construction of the High Line Canal and laterals, with all of the cost charged to the Project as a whole. On March 11, 1913, the Secretary of the Interior responded that the Strawberry Water Users Association had 60 days to settle their differences and arrive at a feasible repayment plan, or "the United States would take such steps as might be necessary to protect its interests" under the contract signed March 5, 1906 by the Strawberry Users Association (Strawberry Valley Project Annual History 1913:9). These steps could even include foreclosing on the property signed over to the Association as collateral for the construction costs.

In an effort to help resolve the problem, the Secretary of the Interior called representatives of the Spanish Fork River canal companies and the High Line companies to Washington on May 1st. Still no agreement could be reached. The deadline passed, but the Reclamation Service delayed taking any serious action. On July 19, Newell received an application from the Spanish Fork River water users to lease 50 second-feet of water from the Strawberry Reservoir. The same day Newell also received a pro-

test from the prospective High line Canal users to the lease application. The Reclamation Service now took the initiative and called a meeting in Provo for the end of August.

The Service sent their long-time attorney Morris Bien, and several other lawyers to propose a compromise plan. The real need of the Spanish Fork River Canals was to guarantee themselves a fixed amount of water every year for the land irrigated by each canal. As it stood now, most of the land had a mix of primary and secondary rights. In drought years, many farmers lost crops. Morris Bien proposed to segregate certain lands under each canal that would be mortgaged to the Service as collateral for construction costs. The number of acres segregated was determined by the difference between the fixed amount of water needed to irrigate all of the land and the Spanish Fork River`s lowest annual discharge over the last decade. This plan also called for the Strawberry Water Users Association to build the High Line Canal, laterals, and extensions itself by raising money by charging those lands to be benefited directly. The High Line Canal Companies objected violently to this idea and the meeting ended without a resolution.

On October 20, 1913, the Reclamation Service made another offer to the Strawberry Water Users, giving them 60 days to accept. The Service offered them a choice between the Land Segregation Scheme, or a straight, long-term agreement for the Spanish Fork River canals to buy 38,500 acre-feet a year. (A figure which Reclamation engineers had determined as adequate to meet the needs of the five canals.) Ten days later, the Strawberry Water Users Association Board met, and decided to split into two separate Associations--Spanish Fork River and High Line Users.

Frederick Newell made another trip to Utah in mid-November to help hurry an agreement, and confer with Payson and Mapleton farmers about construction of the High Line Canal. Meanwhile, members of the Spanish Fork Water Users Association had begun quarreling among themselves. Farmers in the Lake Shore unit wanted to accept the Service`s offer of a guaranteed 38,500 acre-feet every year, while the other four canals did not. On December 13, the four remaining canals in the Spanish Fork Association informed Assistant Secretary of the Interior Albert Jones that 38,500 was too little, and they would "accept" 43,000. Jones replied that 38,500 was all they were going to get, and gave them 60 days to accept one of the two original plans.

In an act of faith, the Reclamation Service went ahead with planning for the High Line Canal during 1913. Numerous designs for tunnels, canal sections, flumes, weirs, settling basins, laterals, and turnouts were drawn. Surveyors studied the topography, soils, and land usage and prepared a route map for the main canal. The following year, the full system of laterals and ditches was completed and mapped.

The repayment dispute dragged on into 1914. In January, the original Strawberry Valley Water Users Association told Newell that it was impossible to get everyone to agree on either the Land Segregation scheme or the straight purchase of water, and asked the Reclamation Service to cancel the original contract of March 5, 1906. The Water Users Association asked the Service to begin negotiating with each of the smaller companies about repayment. which Newell did on March 25, 1914. Those who needed the water most, were quick to start negotiations. The High Line Canal users elected a committee to represent them and began pushing for immediate construction of the distribution system. The Lake Shore and Mapleton irrigators were not far behind in initiating talks with the Service, but nothing was heard from the four main Spanish Fork River canals.

A Reclamation Service Board of Engineers met on August 7, to decide on the proposals put forth by the various canal companies for the cost and delivery times for their water. The Lake Shore farmers wanted only small amounts of water late in the season, because they already had a flood right to the Spanish Fork River. The Board recommended selling Lake Shore water at $45 an acre-foot when they needed it. Having no existing water rights, the Mapleton and High Line Canal Users asked for water for the complete May to September growing season. It now appeared that they would be saddled with the extra construction cost as well. A further split occurred, however, between the Mapleton Water Users. The incorporated towns of Springville and Mapleton already had a partial supply from Hobble Creek, and they wanted water under the same terms as Lake Shore. Farmers outside the town limits were in the same predicament as those under the High Line Canal, so they wanted May to September rights.

Strawberry Project Manager James Lytel described the Service's approach to these protracted, intensely fought negotiations:

> In negotiating for the sale of water to the different units on the project, it has been necessary to hold numerous public meetings on each unit for the purpose of explaining details, also numerous meetings with the Board of Directors of the different canal companies and to convene a number of consulting boards in order to determine on the best policy to follow in connection with important problems. This all required a great deal of time and considerable expense, and while no results are apparent, yet it is believed that in the end, these negotiations will be the means of enabling the Reclamation Service to adopt policies that will be more satisfactory to everyone concerned. The passing of the Reclamation Extension Act will result in the average land holder being able to secure water without burdening himself beyond his limit (Strawberry Valley Project Annual History 1914).

1914 was a year when the Reclamation Service nationally was concerned about the financial limits of settlers on their projects. In most Service projects, irrigation works were built for unsettled public lands. Settlers during the first years were required not only to bear the heavy financial burden of clearing the land and establishing a farm, but the burden of repaying Reclamation construction costs as well. By 1914, it was evident that settlers on Reclamation projects would need longer to pay. The Reclamation Extension Act increased the payment period from 10 to 20 years nationwide.

By June 20, 1914 the High Line Canal Water Users had filed 16,000 acres of water applications. The Service prepared final maps, engineering drawings, and cost estimates that summer and fall in preparation for construction in 1915. (See Figure 66.) With the active solicitations of farmers on the Mapleton Bench, surveys and design work were also undertaken for the Mapleton Lateral, which resulted in a feasible plan calling for a siphon from the power canal, across the Spanish Fork River, and under the D&RGW railroad tracks. An important feature of this survey work was land classification according to the type of crop it was possible to grow. Later repayment schemes would use these classifications as the basis for setting a fee.

In January 1915, the four remaining Spanish Fork River canal companies came to a settlement with the Reclamation Service on the purchase of water from the Strawberry Valley Project. Each canal signed a separate agreement, but the agreements had identical provisions:

(1) Water would cost $45 an acre-foot and could be purchased in 1/2-acre-foot increments from 1/2 acre-foot to 2-acre feet as needed.

(2) Water would be delivered to the canal headgates as called for by the farmers anytime between May and September inclusively.

(3) Each canal would be responsible for its own operation and maintenance.

(4) Each irrigator had to pay a 5 percent building charge before his water right application could be approved.

(5) The canal companies had 15 years to repay the construction cost--5 percent for the first 5 years, 7 percent for the next 10.

The winter of 1914-15 was drier than normal, and the expected shortage of water the next summer hurried the application process for water under these four Spanish Fork River canal contracts. The flood of applications proved so large, that Lytel decided to provide the water upon payment of the 5 percent build-

ing charge, so that water delivery during the dry summer was not delayed upon processing of the applications.

Just after January 1, 1915, construction began on the High Line Canal just below the diversion works for the Powerhouse. The plan called for dividing the 17 1/2 miles of canal and 43 miles of laterals into 9 divisions, each to be let separately for bid. The High Line Canal utilized a variety of construction methods dictated by the terrain and the nature of the soil. Concrete flumes were placed in areas where the slope was very steep and the soil too porous to hold water very well. Where the slope was too steep at one point in the canal above Salem, Utah, the plan called for a 230-foot tunnel. Of the High Line Canal's 17 1/2 miles, 6.6 miles were lined with 4 inches of concrete reinforced with wire mesh. The lining prevented water loss from seepage through sandy or porous soil on relatively shallow slopes.

Until the canal construction had passed Payson, plans called for a lateral system composed of small ditches primarily to cover the high benchland not watered by the Salem Canal. Once the canal had crossed Peteeneet Creek by means of a siphon it began branching off into a number of major laterals, which irrigate large areas south and west of Payson. Lateral 20 leaves the canal just south of Payson and loops west then north around the city. The High Line Canal continues westward until it reaches the southern tip of West Mountain where Lateral 30 breaks off to the north and waters lands on the east side of West Mountain. A short distance further on, Lateral 31 leaves the canal in a southwesterly direction. The High Line Canal finally ends by splitting into Lateral 34 and 32.

During the 1915 construction of the High Line Canal, six engineering parties under A. B. Larson monitored the contractors. The engineers made sure that the excavation followed the grade and contour, that the concrete was to the right specifications, and that all of the work was in accordance with the contracts. Engineers placed benchmarks in the concrete of intake structures and flumes, and used them to lay out the route of the lateral after it left the intake.

On December 1, 1915, the Reclamation Service notified the water right applicants for the High Line Canal that they would be ready to deliver water for the 1916 growing season. The Service requested that they form an organization which could be responsible for operation and maintenance, and for repayment. Shortly thereafter, the Strawberry High Line Canal Company was formed and submitted its Articles of Incorporaion to the Reclamation Service for aproval (Strawberry Valley Project Annual History 1915:42). The High Line Canal charges were somewhat different than those for the existing Spanish Fork canal companies, who could purchase water in 1/2 acre-foot increments costing $22.50. The High Line Users were charged $80 per

irrigable acre for construction costs and 80 cents an acre for operation and maintenance. The High Line Canal was turned over for operation to the Water Users Association on April 24, 1916.

There remained some minor construction on the High Line Canal to be completed during the summer of 1916. Laterals 31 and 34, plus the sublaterals for Lateral 32 went out for bid in May, and the contract was awarded to Ely Construction Co. of Springville in July. Labor shortages and unskilled workmen delayed the completion of this last portion of the High Line Canal until June, 1917. Lateral 34 was designed to irrigate the only public lands under the Strawberry Valley Project, and homesteads were opened in July 1917 for about 2,000 acres on the eastern shore of Utah Lake below West Mountain.

As it crossed the slope of West Mountain, Lateral 34 required a long flume, a piece of engineering which eventually contributed to the Lateral's abandonment. (See Figures 81, 82.) After the public land was opened for settlement in June 1917, homesteaders discovered that much of the land was unsuitable for irrigated crops, and the number of homesteads gradually decreased into the 1930's on the west side of West Mountain. The flume also crossed a number of steep ravines and flooding after a rainstorm would erode its footings, making the structure a constant headache to maintain. Eventually, all of Lateral 34 north of Genola was abandoned and the land used for grazing (Hirst, In Strawberry Valley Project Annual History 1927-65).

The number of farmers applying for water expanded rapidly, begining in 1916. More Lake Shore area farmers applied to purchase water, and the Salem Canal Company applied for water, asking for the same conditions as other farmers in the Spanish Fork River unit. At the end of 1916, the Strawberry Valley Project was supplying water to 28,000 acres.

Much of the construction work now involved minor repairs to the existing project facilities. The Reclamation Service decided to line the Strawberry Dam spillway with concrete, and place a coating of clay over the upstream face of the dam and adjacent slopes to help slow seepage. Along some places where existing canals passed beneath particularly steep slopes, mud and rocks repeatedly cascaded into the canal and caused flooding. Some sections of the Power and High Line Canals were given concrete covers. Silt from Diamond Fork Creek also proved to be a major headache during the first years of operation, as major portions of the creek banks would crumble and wash down into the system. At one point, the High Line Canal was so clogged with silt that water poured over the side into the fields below (Strawberry Valley Project Annual History 1916).

By the summer of 1917, the Strawberry Reservoir was completely full. On July 8th, water began running over the spillway, and the Service opened the sluice gates and allowed Indian Creek to flood back into its natural channel. Sales of water

rights slowed considerably during 1917. Not all the water available from the reservoir was being used. The Reclamation Service began looking at projects farther down the Strawberry River near Duchesne to use the remaining water. Project Manager James Lytel attributed the slow purchase of water rights to Service policy:

> Additional water is needed on many of the Strawberry Valley Project irrigation units, but the policy followed during the irrigation season of 1917 to rent water to those who have not made a water-right application and to give additional water to those who have already made applications had the effect of stopping all sales and execution of new water-right applications, as the average landowner will not purchase a permanent water-right if he can secure a temporary one from time to time as he needs water.

The Reclamation Service took another route to solve its problems with local water users in 1917. Project Manager James Lytel lobbied the Utah State Legislature for a change in the Utah Irrigation District Act of 1909, which would make it compatible with the Service's legal requirements. The 1909 law represented a major change in the irrigation district concept in Utah. Like the earlier district law in California, the 1909 statute gave irrigation districts the authority to issue construction bonds and pay operation and maintenance as well. The district was created by:

(1) A petition of a majority of the landholders.

(2) Survey work and calling of an election by the Board of County Commissioners.

(3) A majority vote for the district.

The Reclamation Service asked that the 1909 law be changed in several ways. In the original statute, each member of the district was given a vote proportional to the number of acres he would irrigate. Since Strawberry Valley Project water users had partial water rights, farmers with the same number of acres, but who would require a different amount of water, would have the same voting rights. The 1917 district law made the voting proportional to the amount of water needed (and the amount of construction cost a farmer would have to repay). The 1917 law also made it legal for an irrigation district to bond directly with the U.S. Government, meaning with the Reclamation Fund, to cover construction costs. Since some reclamation projects might include a mix of public and private land, and settlers on public land did not receive title to the land until construction costs were repaid, the law allowed Utah irrigation districts to enter into a contract with the occupiers of public lands. Finally, the 1917 law allowed the new district to negotiate with existing canals over a fair proportion of the costs for operation and maintenance of the larger system, and then have the whole dis-

trict proposal approved by a district court (Thomas 1920:126-134).

The virtue the Reclamation Service saw in this procedure is that the district required only a majority vote of those within the proposed boundaries, and the dissenters could simply be taxed to pay the bond and maintenance costs. Once a district had been formed, it provided an almost foolproof legal mechanism for guaranteeing that after the construction was done, those in the district would live up to their original contract with the Service.

In 1917, farmers around Springville and Mapleton formed irrigation districts under the new law, at the request of the Reclamation Service. As James Lytel noted in the Project Annual History for 1917:

> Irrigation districts were formed during the year for the purpose of purchasing water for about 10,000 acres located in the immediate vicinity of the towns of Mapleton and Springville. On account of local jealousies, two districts were formed; namely, the Mapleton Irrigation District covering lands between the mouth of the Spanish Fork River and Hobble Creek in the vicinity of Mapleton, and the Springville Irrigation District covering land lying in Hobble Creek Canyon and the vicinity of Springville (Strawberry Valley Project Annual History 1917:143).

The Mapleton District purchased 3,600 acre-feet at $47.50 each and the Springville District 2,400 acre-feet at the same price. Lands without existing water rights typically required 2 acre-feet a year, meaning that a supply equivalent to the High Line Canal would cost $10 more.

In February 1918, the Service signed contracts with both districts, and began construction of the Springville/Mapleton Lateral which eventually cost $131,000 to build.

The plan called for a siphon to draw water from the Power Canal across the Spanish Fork River and under The Denver and Rio Grande Western Railroad tracks. A canal then carried the water across the highest portion of Mapleton bench and eventually emptied into the East Bench Canal. The agreement called for the Service to construct only the 6.75 miles of canal. All laterals would be built by the districts themselves. Construction was finished in the fall of 1918, and water turned into the canal the following spring.

One other important change to Project facilities happened in 1918. On March 25, the Spanish Fork South Irrigation Company signed a contract with the Service, allowing them to divert their portion of the river through the Power Canal and deliver it below the Powerhouse tail race to a new headgate the company would build. The headgate was to be operated jointly by the South and

Salem Irrigation Companies. This change improved the reliability of the flow to the Powerhouse considerably.

By the end of 1918, the Strawberry Valley Project was basically complete. Below the Tunnel's west portal, there were 42.5 miles of canals, and 55 miles of laterals. 7.5 miles of the main canal are concrete lined, and almost all of the lateral system. During the summer of 1919, 42,500 acres were irrigated on 2,000 farms. A number of towns within reach of the Project eventually purchased Strawberry water as well. Payson, Spanish Fork, and Salem entered into the same type of contracts as the farmers, including repayment of construction and a yearly operation and maintenance fee.

Repayment of the higher than anticipated Project cost began to weigh heavily on Project farmers in the early 1920's. Originally, the Strawberry Water Users Association had signed up a little under 53,000 acres at $40 an acre, meaning over $2 million was available for building the Project. With the eventual cost of $3.4 million, and the peculiar repayment plan hammered out with the various water users groups, the charge per acre was:

(1) High Line Division--$80 an acre, with most farms requiring a full supply.

(2) Spanish Fork Division--$60 an acre for those farms requiring only a partial supply, and $90 an acre for those needing a full supply.

(3) Springville/Mapleton Division--$50 an acre for partial supply and $95 an acre for full supply.

The figure for "Acreage Actually Irrigated" hovered between 46,000 and 47,000 for the first few years of the Project, despite the fact the Service had enough water for nearly 59,000 acres. In 1920, they began to search for other areas in southern Utah Valley that could be irrigated by Strawberry water, and investigated the possibility of 10,000 to 12,000 acres near Goshen, or draining and irrigating 14,000 acres adjacent to Salem, Benjamin, and Payson.

By 1921, water users from the various divisions started trying to reorganize a general Strawberry Water Users Association, and on April 25, 1922, The Strawberry Water Users Association reincorporated under Utah law. A preliminary attempt to organize the Spanish Fork River canals failed; but the Reclamation Service wanted to turn over the "care, maintenance, and operation" of the Project to the water users, and drew up a tentative contract for discussion. Beginning that year, they also started regularly referring all operational matters now handled solely by the Service to the new general board (Strawberry Valley Project Annual History 1921).

By mid-1922, the prices of wheat and hay were so low that the Water Users Association began agitating for a deferment of construction charges, or an extension of the repayment period to 40 years instead of 15. Farm prices continued at dismal levels for the next 4 or 5 years. In 1923, a farm price index kept by Utah State University stood at 122, compared with 233 in 1920 (Alexander 1971). Many Reclamation Service projects throughout the United States were in worse circumstances than the Strawberry Valley Project.

A Fact Finders Commission chaired by Elwood Mead was formed in 1923 to study the problem. The Commission recommended that the yearly repayment figure be tied to the annual production value of lands under a project and set a figure of 5 percent of total yearly income. During the first 2 years of its existence, the Strawberry Water Users Association had never been able to garner more than 50 percent of the water users then holding private repayment contracts for the Project. When the recommendations of the Fact Finders Commission were introduced into Congress in 1924 as legislation, many farmers in the area executed deeds of conveyance to the new corporation whereby they transferred all of their interests, rights, titles, claims, demands, properties and possessions relating to water development to the new Association. The Fact Finders Bill passed on December 5, 1924, and negotiation of a contract to turn Project management over to the Association began in earnest.

By September 1925, the Association and the Service had finalized the agreement and all that was left to do was to get enough of the water users to deed their property to the Association to meet membership requirements of the Service. On September 28, 1926, enough water users had joined, that the Reclamation Service and the Association signed a contract turning over the operation and maintenance of the Project to the water users.

Strawberry Valley Project construction had a number of economic impacts. Local businesses, such as the Ely Construction Company of Springville and Henry Gardner's sawmill were the direct recipient of contracts from the Reclamation Service. Much of the construction work force was hired locally as well. The Project needed skilled craft labor, day laborers, and freighters with teams and horses for most of the 12-year construction period. When a majority of the work force was furloughed between July and December 1908, while the Power Canal was under construction, the loss to the local economy was possibly as high as $100,000 (1907 dollars) due to the delay. The negative impact of this unemployment was only partially offset, however, by the rush to finish the hydroelectric facilities. Table 2 below shows rates paid for different classes of labor.

TABLE 2
GOVERNMENT CONSTRUCTION PERSONNEL

Year	Classified Number	Classified Cost	Registered Number	Registered Cost
1907	4	$4660/yr.	2	$385/mo.
			11	$4/day/man
1908	2	2940/yr.	3	$525/mo.
			3	$4/day/man
1909	3	4740/yr.	12	$1885/mo.
			12	$4/day/man
1910	5	7200/yr.	13	$1535/mo.
			8	$4+/day/man
1911	4	6000/yr.	18	$2150/mo.
			27	$4.50/day/man

Source: (Strawberry Valley Project Annual History 1911).

The total employment fluctuated after intensive work resumed in 1909, but remained well over 100 people a month through 1916. In 1913, the average monthly work force exceeded 120 people, with an average of 6 classified and 20 registered Federal employees and 100 private contractual employees. This Federal work force was in addition to workers hired by the construction contractors. In 1916, Federal employment had grown to 150 workers, and peak summer contract work pushed that total to 380. In 1918, however, the construction work force began to shrink, and the average monthly employment dropped to 64.

Public expenditures varied considerably during the Project construction period. Between 1906 and 1911, the Service paid out an average of $250,000 a year; between 1912 and 1913, $400,000; and between 1914 and 1919, $170,000. The major cost overrun on the Project was primarily attributable to conditions that were impossible to foresee, including:

(1) The unreliability of the equipment, which necessitated building a hydroelectric facility.

(2) The presence of a large, continuous stream of water which forced the payment of a bonus to workmen and delayed concrete lining of the tunnel.

(3) The necessity of buying Project lands from the Ute Tribe.

This extra cost, however, was partially offset by the power and grazing revenues, which amounted to about $20,000 a year after 1910. The following two tables (Tables 3, 4) list Project expenditures at two key points--after the completion of the collection and storage system in 1913 and after the completion of the distribution system in 1919.

TABLE 3
SUMMARY OF COSTS, STRAWBERRY VALLEY PROJECT, UTAH
(December 13, 1913)

Submerged Lands	$ 10,000.00
Grazing Lands	67,673.70
Strawberry Dam	267,033.30
Indian Creek Dike	119,249.92
Indian Creek Diversion Canals	114,345.38
Strawberry Tunnel	1,119,238.86
Telephone Lines	14,683.61
Wagon Roads	44,756.81
Power Canal	349,062.15
Powerhouse	86,613.82
Transmission Lines	16,284.97
High Line Canal	20,356.79
Distribution System	5,134.63
Investigation of Project	39,383.69
Administration Buildings	5,260.00
General Expense	2,271.13
TOTAL	$2,361,798.76

Source: (Strawberry Valley Project Annual History 1913).

TABLE 4
SUMMARY OF COSTS, STRAWBERRY VALLEY PROJECT, UTAH
(December 31, 1919)

Feature	Government	Contractor	Total
Examination/Surveys	$ 48,658.27		48,658.27
Storage System	1,466,488.86	$ 232,926.66	1,699,415.52
Canal System	418,057.91	396,648.04	814,705.95
Lateral System	146,850.76	560,141.32	706,972.08
Power System	73,763.29	8,241.13	82,004.42
Farm Units	9,025.68		9,025.68
Perm. Improvements	115,223.25		115,223.25
Telephone System	935.57	13,115.62	14,051.19
O&M During Const.	12,511.90		12,511.90
TOTAL	$2,291,495.49	$1,211,072.77	$3,502,568.26

Source: (Strawberry Valley Project Annual History 1919).

The population of southern Utah Valley during the construction period was about 16,000. It is difficult to gauge the impact that these expenditures had on the local economy. Project employment amounted to about 4 percent of the local total, not a major impact. Southern Utah Valley was still a cash-poor society after the turn-of-the-century, and many of the laborers were local farmers supplementing their incomes. The effect of adding extra cash to this kind of economy might have been much greater because it resulted in proportionaly higher rates of purchase for manufactured items.

One other economic impact resulted from the Project, which is hard to measure in dollar terms. There were a number of construction injuries, such as maimed limbs, amputated legs, and illness from bad drinking water. In fact, up to 10 percent of the work force reported some illness during certain years. The loss of a leg, for example, represents a loss of productivity, but the economic impact is difficult to calculate in dollar terms.

A number of important cost studies were undertaken by the Strawberry Valley Project, which resulted in changes to Reclamation Service construction practices. The main impetus behind the building of the hydroelectric plant was a cost study by Project engineers which determined that it would be cheaper to use hydroelectric power for construction. Only one other hydroelectric facility was under consideration at the time--the Boise Project Power Plant--and both were finished in the year 1908. If not the first Bureau of Reclamation power plant, the Spanish Fork facility is definitely one of the earliest.

The majority of the freighting and construction work for the Project was done with horse and wagon. In 1914, the Project bought its first automobile and began comparing its cost per mile with the horse. By 1918, Project Engineer James Lytel concluded that the operation of the Project's Kelly Springfield Truck was cheaper than horse and wagon.

> Although the cost per mile has been rather high, this condition has been offset to a great extent by the rapidity with which work has been reached and camps moved, and no doubt, has proved economical in comparison with the transportation by team (Strawberry Valley Project Annual History 1918:109).

Once construction was completed, the Strawberry Valley Project continued to have significant economic impacts on southern Utah Valley. After World War I, when prices for farm products fell drastically and there was a farm depression in many areas of the United States, the higher than anticipated repayment costs had a negative impact on the financial well-being of Project farmers. The cost of the Project was a fixed cost which had to be paid whether a farmer made a profit or not. Some Project farmers lost their land during periods of low commodity prices. While not particularly noticeable during the first few years, it later became obvious that construction costs could not be repaid in the 15 years first suggested by the Reclamation Service.

The Strawberry Valley Project also changed the distribution of wealth in southern Utah Valley. There was a transfer in the form of "tax revenue" expenditure to the private sector. This transfer broadened the economic base of local communities by increasing the number of farmers who could expect to bring their entire crop to maturity. Prior to the Project, only those lucky few who arrived early enough to hold a prior right to the Spanish Fork River could reliably expect to make a living from farming. There was also a shift in wealth away from the Ute Indian Tribe to the Strawberry Water Users Association when the 60,000 acres were withdrawn from the Reservation for the Project. Although the Utes were eventually paid $71,085 for this land, this expense was recouped by the Project in a little over 6 years from grazing lease fees. It is also possible that some shift in wealth from the private to the public sector likewise occurred, given the surrendering of the original "private" water rights to a public agency and the requirement that all farm land be used as collateral in paying for the new water appropriations. The initial net distribution, however, was undoubtedly toward the private sector.

The Reclamation Service learned from the early economic effects of the Project as well. The Strawberry Valley Project was unique among the early Reclamation Service projects, in that a majority of the land was privately owned, and the farms served by the Project were part of already existing communities with an

infrastructure of roads, schools, public buildings, stores, and homes. In other Reclamation projects where the land was in public ownership, there were considerable costs associated with settlement in addition to the cost of water. While there were some failures, the Strawberry Valley Project for the most part did not suffer these problems.

The structuring of the original repayment contracts placed a too heavy emphasis on income from irrigated agriculture as well. The Powerhouse was originally built only with the idea of providing cheap power for construction activities. By 1920, most of the small towns in southern Utah Valley received all or part of their power from the Spanish Fork Powerhouse, which by that time was generating substantial revenues. The profits from grazing and recreation were never recognized either. By the time the new Strawberry Water Users Association was formed in the 1920's, and the repayment schedule renegotiated, the Reclamation Service had begun to recognize these sources of revenue and include them in their project planning.

Finally, the increased drainage problems caused by irrigating the high bench areas were never recognized during the planning. Considerable expense was involved in draining a share of the wet lands increased by Project irrigation, and some of the lands have never been drained.

After irrigation began in 1915 in southern Utah Valley with Strawberry water, and since that time, the Project has continued to have a major economic impact in the area. Designed primarily to increase agricultural production, the Project had a major impact on grazing, electrical power, and recreation as well. While these benefits are directly attributable to the Project, there have also been a number of important secondary benefits, which were not foreseen during the early Project planning.

VII. STRAWBERRY VALLEY PROJECT--OPERATION

When the Strawberry Water Users Association assumed responsibility for management of the Project in 1926, they were faced with the problem of creating a system for distributing the right amount of water at the right time to thousands of shareholders. They had to devise a distribution method which could be adjusted according to the weather, the locale, the type of irrigation, and the type of crop. The ultimate purpose of this system was two-fold; first, the system had to insure that everyone got his "fair share;" and second, it had to use all of the water available to the Association efficiently.

The Association has other water rights besides the water in the Strawberry Reservoir, including:

(1) the 6 to 7 second-foot flow in the tunnel.

(2) previous rights to the Spanish Fork River, including a spring runoff right that the High Line Canal possesses.

(3) a spring runoff right to Payson Creek which is sometimes intermingled with High Line Canal water.

The distribution method used by the High Line Canal is typical of the other canals under the Project. It distributes its water using a "call" system. Every year, each farmer is issued a card which describes the number of water shares he owns and lists the "turnout" number for his fields. Some farmers own adjacent parcels of land and others own widely scattered plots. Each farmer fills out a card every week which lists the places and times that he wants his water and drops it off at the Strawberry Water Users Association Office. A "scheduler" then calculates the schedule of irrigation times for that week for the entire canal with the intention of keeping the canal full all the way to the west end without wasting any water and insuring that each farmer gets his water when he asked for it.

The schedule then goes to the "ditch riders" who travel back and forth in their assigned section of the canal all day, turning the water onto the fields. The scheduler makes periodic field checks to supervise the ditch riders and monitor their adherence to the times and places specified in the schedule. In the early days, the ditch riders used a two-wheel, horse-drawn cart with one of the tools of their trade--a long ruler--hanging from the back. At the beginning of each lateral was a measuring box. After the turnout had been opened, the ditch rider would place the ruler on the lip of the box and measure the depth of the water. The turnout was then left opened for the amount of time prescribed by the scheduler.

The scheduler also controls the release of water from the Reservoir. Each morning at 6 am during the irrigation season,

the scheduler places a call to the office at the tunnel's east portal and requests that a certain amount of water be released that day. During the spring months, when the High Line Canal can sometimes use its runoff right to the Spanish Fork River or Payson Creek, the scheduler must calculate the flow available from the River and Creek and adjust the amount released from the reservoir accordingly. As if this job weren't complicated enough, the scheduler also has to make thousands of minor adjustments to the distribution system occasioned by rentals of water or by an unexpected rainstorm. Some of the water users, particularly those growing forage crops, will not need their share if the rain has given the ground a good soaking. Water rentals generally occur because a share entitles everyone to the same amount of water. and farmers in the lower areas of the Valley with a higher water table often do not need their full share. The unneeded portion of these shares is rented to farmers on the high, better drained bench areas.

This system has worked well for many years with only minor difficulties. Occasionally during June and early July problems will arise in keeping an efficient schedule. Many of the farmers growing forage crops ask for their heaviest water use during this period. The canal will often run to capacity for several weeks at a time and the ditch riders will have to work longer hours to keep the water flowing into the proper fields. The trend to more, smaller farms within the Project area has also recently complicated water distribution. The Association has begun asking owners of small plots on a lateral to act as their own ditch rider. In general, however, during the May to October growing season, the canal has plenty of capacity to provide water for the orchards, family gardens, and other crops having a much longer irrigating season (Christiansen 1981).

For most of the 70 years since the Project was built, the Strawberry Reservoir has delivered 100 percent of every water share, which usually meant that between 60,000-70,000 acre-feet were released through the tunnel each year. With four years storage capacity in the Reservoir, the Association has been able to even out the periodic drought years, but sometimes a smaller percentage was all that could be provided. Particularly during the severe drought of the early 1930's, the Association delivered a greatly reduced water share for several years in a row. In 1933, for instance, the level of the Reservoir had fallen so low that the remaining water could not be drained through the tunnel's east portal intake works. In 1934, the Water Users Association dredged a 5-foot deep channel toward the center of the Reservoir and built a new intake structure at a lower level that allowed another 15,000 acre-feet of what had previously been "dead storage" to be drawn out. It was during this same period, that the Currant Creek Feeder Canal was built by the Civilian Conservation Corp to divert 6000-7000 additional acre-feet of water into the Reservoir. In 1934, the Water Users Association delivered only a 15 percent water right (Strawberry Valley Project Annual History 1927-65; Christiansen 1981).

The Depression of the 1930's affected the Project in other ways. Even at the much lower payments the Association had negotiated in 1926, Project farmers still had trouble meeting payments during the hard economic times. The situation got so bad that many in the Association feared a default on the loan and began negotiating with the Bureau for a way to reduce the Association's costs. The 1939 passage of the Reclamation Projects Act spurred the negotiations. The Act extended the repayment period for Bureau projects nationwide, and a year later, in 1940, the Strawberry Water Users Association signed a new contract with the Bureau governing all aspects of the Project, including a reduced annual payment.

The 1940 contract consolidated in one document a number of contracts, legal opinions, and understandings governing the Strawberry Project's administration. While the water users were prmarily concerned at the time over reducing the cost burden on their farms, the Bureau wanted to insure that the Federal government retained legal title to the reservoir, irrigation system, and grazing lands. The original National Reclamation Act of 1902 specified only that management and operation of reclamation projects would pass to the water users when a majority (51 percent) of the construction costs had been repaid, but legal title to the facilities was always intended to remain with the Government. The Fact Finders Bill of 1924 changed the requirement for turning over operation and maintenance. Water Users under this Bill assumed control when two-thirds of them had executed repayment agreements with the Bureau of Reclamation. Although the Strawberry Water Users Associaton could not have assumed "care, operation, and maintenance" in 1926 under the National Reclamation Act's original stipulation, they were able to under the Fact Finders Bill, which served as the legal basis for the 1926 contract. The one sticking point in the question of title was the grazing lands purchased under the authority of the 1910 Act authored by Congressman Sutherland. The 1910 Act gave title to the grazing lands to the Association after construction costs had been repaid. In 1940, the Bureau insisted that legal title to the grazing lands must rest with the government. At the time, the water users, concerned chiefly with costs, cared only that the income derived from those lands continue to help repay the loan. They also feared that if title rested with the Association, it would be liable to Wasatch County for property taxes--an expense which they did not want.

The final installment of the $3,499,734.22 construction loan for the Strawberry Valley Project was paid on November 30, 1974. That same year, the Strawberry Water Users Association filed suit against the Bureau of Reclamation to settle a number of important legal issues relating to the Project, including:

(1) Where did title to the grazing lands actually rest?

(2) What was the legal business structure for the Association allowable under the National Reclamation Act and

its amendments? Could it distribute profits to its members now that the construction loan had been repaid?

(3) Did the Association have a right to be reimbursed for grazing land lost under the expanded Strawberry Reservoir in the Central Utah Project?

The US District Court ruled that under the 1940 contract, the Federal government held legal title to the grazing lands, but that the Association should be compensated for revenues lost as part of the Reservoir expansion plan. The court also ruled, however, that under the law, the Strawberry Water Users Association could not distribute profits to its members. All revenues arising from the sale of grazing leases, power, and recreation were to go for the operation and maintenance of the system. Under this decision, the Strawberry Valley Project will continue to provide low cost irrigation water for southern Utah Valley farmers for years to come, with the cost of that water essentially subsidized by other revenues.

Originally, the Strawberry Valley Project was designed as an agricultural project. The Bureau fully anticipated that agricultural production could repay the construction loan by itself. In the intervening years, however, revenues from grazing, electrical power, and recreation have grown in importance to the Strawberry Water Users Association until they now overshadow sales of irrigation water to agriculture as a source of funds. The nature of agricultural production has changed dramatically as well. A broad variety of crops originally grown on Project lands has given way to extensive production of forage crops and orchards.

VIII. AGRICULTURAL PRODUCTION

The Strawberry Valley Project made a significant change in southern Utah Valley agriculture. Prior to the Project, the major share of the land was farmed under a partial irrigation scheme. The land would be irrigated only while water was available from the Spanish Fork River and other area creeks. A portion of the land within the Project boundaries was also dry-land farmed prior to completion of the Project. So, while most of the land was in production prior to the Project, it was not producing all that it could. In a report prepared for the Strawberry Water Users Association, A. F. Engberg described agriculture in the area in 1915:

> ...The elevation of the land to be irrigated is between 4,500 and 4,800 feet. The area of mesa land and the area of bottomland is about equally divided. The soil of what is known as the "Lower Valley," lying directly below Spanish Fork, Salem and Payson City, is a black, sandy loam, going down from 5 to 15 feet. Under this is a stratum of sand and gravel through which flows an inexhaustible stream of pure water. This low land soil is extremely fertile, easily worked, and retains moisture remarkably well. With proper cultivation, garden truck will grow for weeks without either rain or irrigation.
>
> The soil in the mesa fruit belt is a sandy loam with gravel, and bids fair to rival the Colorado fruit districts as soon as ample water supply is provided. Local conditions, the climate, soil protection from severe frosts and icy cold winds, moderate altitude, abundant sunshine, and mositure at proper time give fruit flavor, texture, color and keeping qualities that are unsurpassed.
>
> At present, tens of thousands of young peach trees are planted on the highlands under the Strawberry Project. The peaches of Utah Valley are at the top. Their delicious flavor and richness of color, and their shipping qualities, places Utah Valley peaches above competition. The Elbertas, late Crawfords, and the Wheatland types grow to an enormous size and always bring the highest price.
>
> It is hardly necessary to go into detail regarding the productiveness of other classes of fruits in Utah Valley soils. Apples, nectarines, plums, prunes, pears, apricots, cherries, cantaloupes, watermelons, and all types of berries grow to perfection.
>
> It is fortunate that three great staple products, sugar beets, alfalfa, and barley have a natural market.

These have become universal crops in the vicinity, and any man with a piece of irrigated land can do well without growing anything else.

ALFALFA.--The story of alfalfa is one of the oldest and most often told. It is always a tale with a golden sequel for the farmer. Utah Valley is the home of this forage crop with its tender growth of small stalk and an abundance of leaves. The rank, woody hay of Eastern states is unknown here. From 5 to 7 tons per acre is the annual average. During the fall of 1908, hay was sold for from $7.00 to $9.00 per ton in the stack. In February, March and April, 1909, baled alfalfa was selling in Spanish Fork at $15.00 to $18.00 per ton. Alfalfa is the greatest all-round crop of the Valley. It is attended with a minimum of labor, is constantly enriching the soil and is as sure as anything can be.

GRAINS.--The wheat crop on irrigated soil yields from 40 to 50 bushels to the acre, and on dry land, depending entirely upon the rainfall, 10 to 20 bushels is a modest estimate. Barley and oats yield from 65 to 100 bushels per acre. During the fall of 1908, more than 300,000 bushels of barley were shipped from this district to Eastern and Western markets, bringing from $1.05 to $1.10 per cwt., loaded on the cars. A sample of barley grown by A. W. Johnson of Spanish Fork received highest award at the 15th National Irrigation Congress held at Sacramento, California, 1905.

SUGAR BEETS.--Sugar beets hold, and will always do so, an important place in the agricultural development of this section. The soil is especially adapted to their culture. Tests for sugar show a very high percentage, and this with the established fact that a large tonnage per acre could be obtained led to the establishment of the great Lehi Sugar Factory, also the building of two auxiliary plants of massive dimensions in the very heart of the land under the Strawberry Project. One of these factories is situated 1 mile to the west of Spanish Fork, the other lies 4 miles to the northeast. The farmer does not have to ship his beets to a distant market, he simply hauls them to the nearest factory and gets his money. Feight rates cannot take away the profits.

Even the residue, the pulp, is not wasted. There is nothing better to fatten stock with, and the farmer is willing to buy it back at a reasonable figure. About all that is involved is the work of hauling. In connection with the plants near Spanish Fork, large feed yards are established. Thousands of cattle were fed in these yards last winter.

> It can be truthfully said that there is hardly another industry applicable to a rural community that brings a benefit to the farmers and to the city near where it may be located as great as that resulting from a beet sugar plant. It must employ a large number of operatives, who, with their families, aid the cities themselves in no small way; but its greatest work is in putting money into the hands of the producers. It opens for them a market, that will always pay good prices. Even where all material and help must be paid for, the soil under the Strawberry Project pays a good dividend.
>
> The present sugar beet acreage in this vicinity is 3,000. The respective division of acreage is 2,000 for Spanish Fork, 700 for Payson and 300 for Salem. Fifteen tons per acre is the average crop, but in many instances an acre will yield 22 tons (Engberg 1915).

In 1915, the Project provided water for approximately 8,900 acres in the Lake Shore, Spanish Fork, and Clinton Districts. The High Line system had not yet been completed. While some land had been placed into orchard prior to the completion of the Project, little additional land was put into orchards as a result of the increased availability of water. In 1915, orchards provided only a low return since the local market for fruit had been saturated, and there were no nearby canneries. Sugar beets had been grown in the area prior to the completion of the Project, but additional acreage was converted into sugar beets as more water became available. In the first year, the local sugar beet factory operated at 133 percent of capacity.

For 1915, Table 5 shows the acreage under subscription for each of the canal companies:

TABLE 5
PROJECT ACREAGE UNDER SUBSCRIPTION IN 1915

Canal Company	Acreage
East Bench	2887
Lake Shore	1902
South Field	1882
Mill Race	1470
South East Field	58
Clinton District	689
TOTAL	8888

Source: (Strawberry Valley Project Annual History 1915).

By 1923, there were 25,000 acres in the Project's High Line Division under some form of water right; 32,000 under the Spanish Fork Division; and 10,500 under the Springville/Mapleton Division. There were 723 farms under the High Line Division; 1347 under the Spanish Fork Division; and 747 under the Springville/Mapleton Division. The High Line Division held 19,153 acres under a complete Project water right. The Spanish Fork Division held only 3,200 acres under complete Project rights and another 9,662 under partial Project rights. The Springville/Mapleton Division had 10,000 under partial water rights. As Table 6 shows, the following lands were irrigated and crops grown in 1923.

TABLE 6
IRRIGATION AND CROP RESULTS

(Project Proper) Division	Irrigable Acreage	Irrigated Acreage	Cropped Acreage	Crop Value Total	Crop Value Per Acre
High Line	19,700	18,265	15,165	549,580	36.24
Spanish Fork	3,200	3,100	3,000	148,650	49.55
Springville/ Mapleton	2,200	2,100	2,000	134,650	67.06
TOTAL	25,100	23,465	20,165	832,880	41.55

Source: (Strawberry Valley Project Annual History 1924).

This chart reflects lands requiring only a full supply, and for which an accurate crop value per acre could be determined. The Project provided a partial supply for another 47,460 acres. For the lands which received only supplemental water, the Service calculated that since the Project was responsible for an average of 52 percent of the water used on these lands, 52 percent of the crop value should be attributed to the Project (Strawberry Valley Project Annual History 1923). Given that the water was usually applied late in the season and that most of these crops would not have matured, this estimate can be considered as a lower bound of the actual value that should have been attributed to the Project.

In 1924, Bureau of Reclamation economists noted that too much time and effort had been expended in the past growing low priced forage for cattle and not enough time spent in enterprises that could provide a more lucrative return. The Bureau feared that existing agricultural practices could not reliably pay for the Project. In addition, a drainage problem occurred in 1924 due to the increased application of water in the higher areas as a direct result of the Project. Although the Government offered Federal aid in reclaiming some of the land, their offer was

refused. (Strawberry Valley Project Annual History 1924). The Bureau suggested that Project farmers increase the number of dairy cperations (Strawberry Valley Project Annual History 1924). There was also encouragement given in the area of truck gardening.

The year 1924 was one of the driest years in history for the Project lands. Crop production levels were generally short because of the prevailing hot winds and lack of rainfall. Increased irrigation did not seem to materially benefit the crops. The sugar beet crop was almost a complete failure. Grains suffered also, but alfalfa reached its average yield. During 1924, the United States provided an additional 35,000 acre-feet of water from the Strawberry Reservoir, that no doubt saved several thousand acres of alfalfa. (Strawberry Valley Project Annual History 1924).

In 1925, the Bureau made a significant change in the procedures used to determine a farmer's ability to pay for water, based on the Fact Finders Bill (Strawberry Valley Project Annual History 1925). In January, the Commissioner of Reclamation authorized the classification of Project lands into six classes according to their productivity with the intention that the annual repayment to the Reclamation Fund would be based on crop production, rather than a fixed fee. Land classification rules were established for only Classs I, II, III, and V lands because the Bureau determined that there were no Class IV or VI lands in the Project area. After the land was classified, a notice was sent to the owner stating the class into which his land had been placed, and requesting him to appear before the committee if he had any objections to the classification as made. These classifications had very significant implications concerning payback ability and individual farm wealth.

First Class was obviously the best land. All land of good fertile soil not adversely affected by subsoil conditions; ground water, alkali, topography, rocks, or short growing season fell into this category. On a per-acre basis, these lands were said to be capable of producing 4-5 tons of alfalfa; 50 bushels of wheat; 75 bushels of oats; 80 bushels of barley; 15-20 tons of beets; 2 tons of threshed peas; 10 tons of tomatoes; and 300 bushels of potatoes. The gross annual income, hence payback potential, was assumed to average three times that of Third Class lands.

Second Class land was assumed to be "average" land lacking a portion of the positive attributes of Class I, and essentially consisted of all land falling between Class I and Class III. These lands actually comprised the major portion of the Project area. They were assumed on a per-acre basis to be capable of producing 3-4 tons of alfalfa; 30-40 bushels of wheat; 40-50 bushels cf oats; 10-15 tons of sugar beets; 1 and 1/2 tons of threshed peas; 6-8 tons of tomatoes; and 150-200 bushels of potatoes.

The Third Class lands were considered to be the poorer land. Class III lands were seriously affected by lack of fertility, poor subsoil conditions, ground water, alkali, topography, rocks, or short growing season. Much of the land brought into cultivation since the completion of the Project fell into this category. These lands were said to be capable of producing 2-3 tons of alfalfa; 15-25 bushels of wheat; 25-35 bushels of oats; 30-40 bushels of barley; and 5-8 tons of sugar beets. Few other crops could be grown on this land.

Since the Project's completion, the gross annual per acre income from Class I land has averaged $75; Class II land averaged $50; and the Class III land averaged $25. On the basis of 5 percent of the gross annual per acre income, an annual construction repayment charge of $3.75 per acre of Class III lands were assessed.

While it is not possible to know with any certainty, given the limited data currently available, there exists a distinct possibility that some shifts in relative wealth positions between Strawberry Project farmers took place under this new repayment scheme. This scheme also implicitly recognized that the ability to pay for water differed by land type. This policy no doubt improved the financial or cash-flow position of some Project participants at the expense of others, but was certainly more equitable than previous payback schemes.

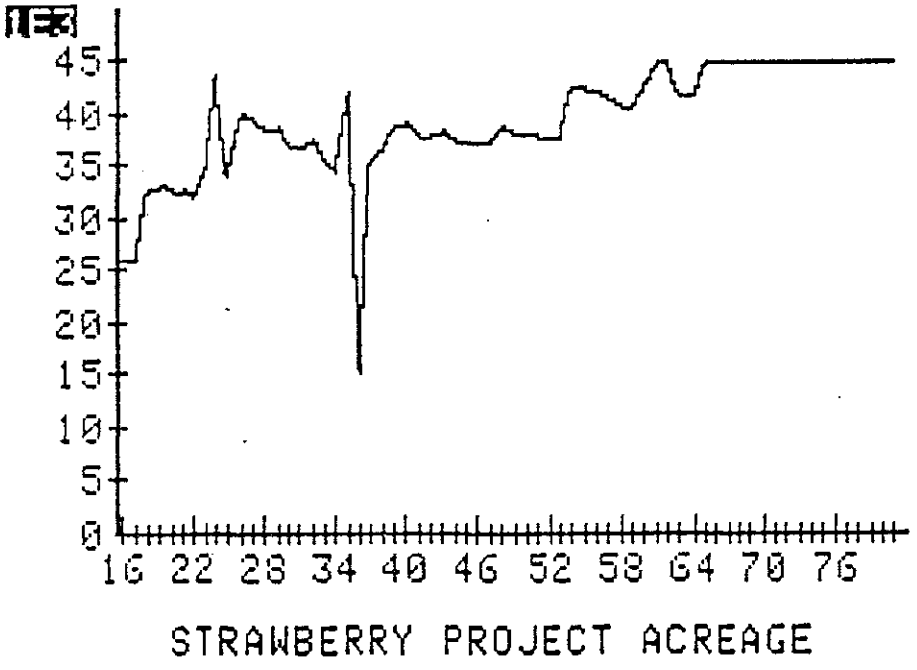
In 1925, a canning plant was built near Spanish Fork. Project farmers received contracts for higher priced truck crops such as peas, beans, and tomatoes. The extremely low temperatures during the winter of 1924-25 killed or injured many peach and early fruit trees, which resulted in a substantial loss of the peach and cherry crops. The yields of all other crops were average or above average. The area under truck crops (peas, beans, tomatoes, etc.) increased to 1,600 acres with some individual returns in excess of $200 to $300 per acre. The sugar beet crop was exceptionally heavy, averaging over 13.6 tons per acre over the entire Project area.

The acreage farmed under the Project has changed over time; however, since 1922 most of the eligible Project acreage has been in production. (See Graph 1.) The only exceptions occurred during the early 1930's.

An issue of more recent concern has been the shift from full-time to part-time farmers. In 1923, there were a total of 2,817 full-time farmers receiving full or supplemental irrigation water from the Project. In 1966, there were only 185 full-time farms receiving full irrigation service and another 260 full-time farms receiving supplemental service. An additional 830 part-time farms were receiving Project water on a full or supplemental service basis. By 1970, the number of full-time farms receiving full irrigation service had dropped to 180, and by 1975, the number of full-time farms receiving full irrigation service had declined further to 97. Even the full-time farms receiving

supplemental irrigation service declined to 130. The part-time farms rceiving either full or supplemental irrigation service had risen to 1,110. While the total number of farms has increased since 1965, the number of full-time farms has declined rather dramatically. Statewide farm numbers within Utah have followed a similar pattern. The full implication of such shifts are not yet well understood.

GRAPH 1
STRAWBERRY PROJECT ACREAGE

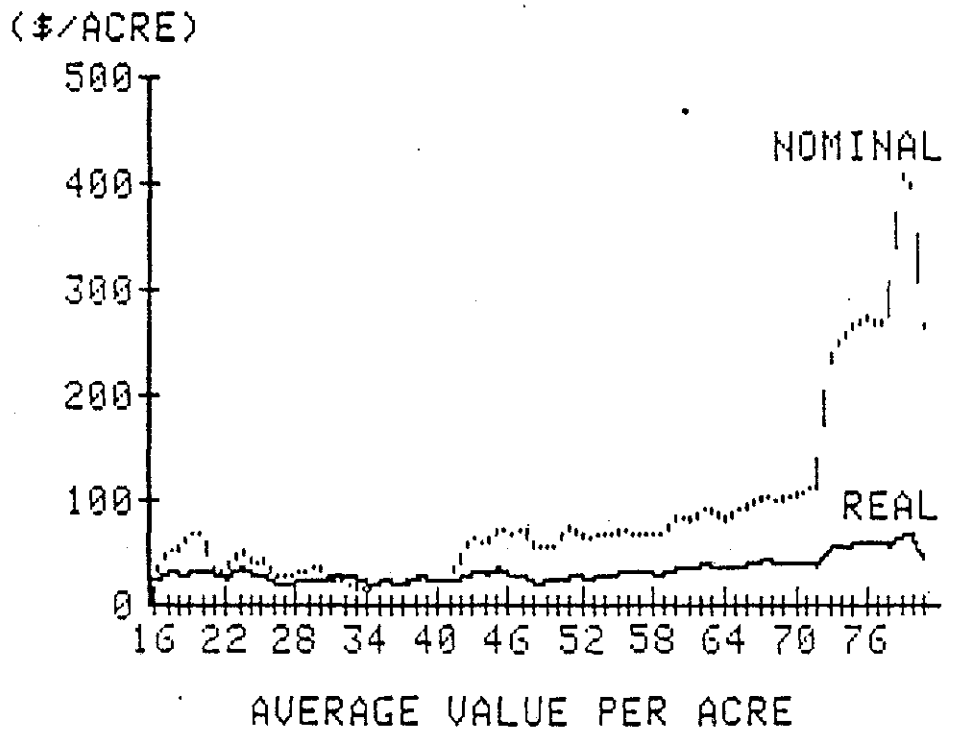


Source: (Strawberry Valley Project Annual Histories 1916-80).

CROP VALUES

The average value per acre of crops grown under the Strawberry Valley Project has changed substantially over the years. (See Graph 2.)

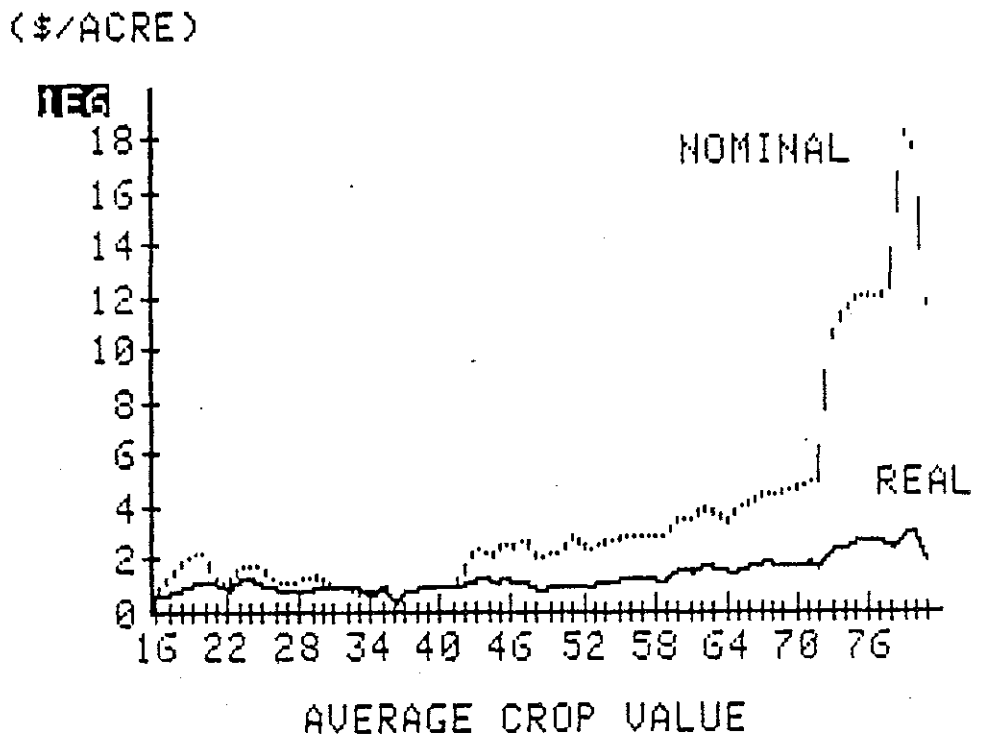
GRAPH 2
AVERAGE VALUE OF CROPS - STRAWBERRY PROJECT
(DOLLARS PER ACRE)



Source: (Strawberry Valley Project Annual Histories 1916-80).

In nominal or current dollar terms, there has been a rapid increase in crop values since the early 1970's, until 1980 and 1981 when nominal returns declined. In real terms, there has been only a slight increase in average per acre crop values since 1916. The total value of crop production over this same interval likewise shows an improvement in nominal crop values. (See Graph 3.) When those gross crop values are converted to real terms, the increase has not been as dramatic, although it has shown a positive increase. While it would be rather spectacular to aggregate these values over time to show the overall value of the Project, this would overstate the Project's value because only a portion of the value of these crops can be attributed to the increased availability of water. In 1916, average value per acre of crops produced within Project was approximately $30.00. That value remained the same until 1970, when it climbed to approximately $50.00 an acre, and then declined to levels consistent with early 1940's.

GRAPH 3
TOTAL VALUE OF CROPS - STRAWBERRY PROJECT



Source: (Strawberry Valley Project Annual Histories 1916-80).

In 1921, the Bureau estimated that the per-acre cost of raising wheat was $26.95; sugar beets cost $67.65; alfalfa cost $13.20; and potatoes cost $37.05. By 1923, the cost of production had risen dramatically. The production costs and selling price on a per acre basis are shown in Table 7.

TABLE 7
COSTS AND RETURNS OF AGRICULTURAL PRODUCTION - 1923

Crop	Cost Per Acre	Selling Price Per Acre
Wheat	42.21	27.40
Sugar Beets	87.37	87.81
Alfalfa	31.10	36.50
Potatoes	71.05	103.33

Source: (Strawberry Water Users Association Annual Project Crop and Livestock Report 1923).

Project farmers who raised wheat lost a considerable amount of money that year. Alfalfa and sugar beet farmers broke even. The average yield of wheat, sugar beets, alfalfa, and potatoes was 35 bushels, 10 tons, 3.5 tons, and 200 bushels respectively. The average price in 1923 was $.78/bushel for wheat; $8.79/ton for sugar beets; $10.43/ton for alfalfa; and $.51/bushel for potatoes. Prices for sugar beets and potatoes increased only minimally by 1946, while alfalfa and wheat had shown somewhat larger increases. (See Table 8.)

TABLE 8
PRICES FROM 1946 CROP CENSUS

Crop	Unit	Price Per Unit	Comments
Wheat	Bushel	1.70	
Alfalfa Hay	Ton	18.00	
Potatoes	Bushel	.60	
Sugar Beets	Ton	9.16	

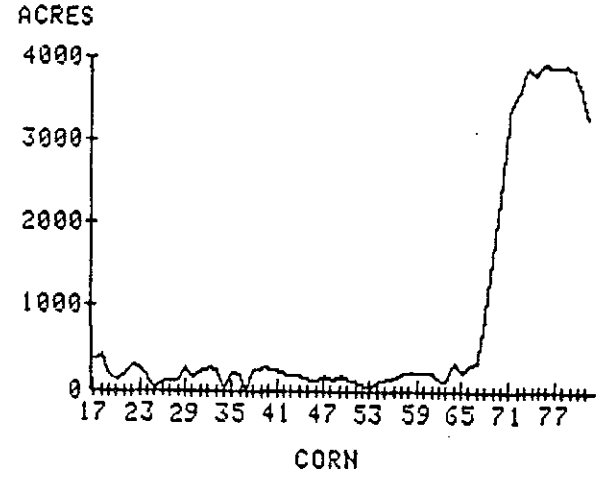
Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1921, 1923, 1946.)

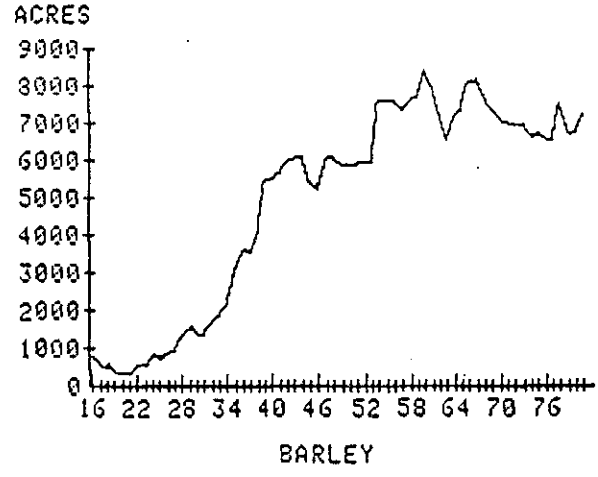
CROPPING PATTERNS

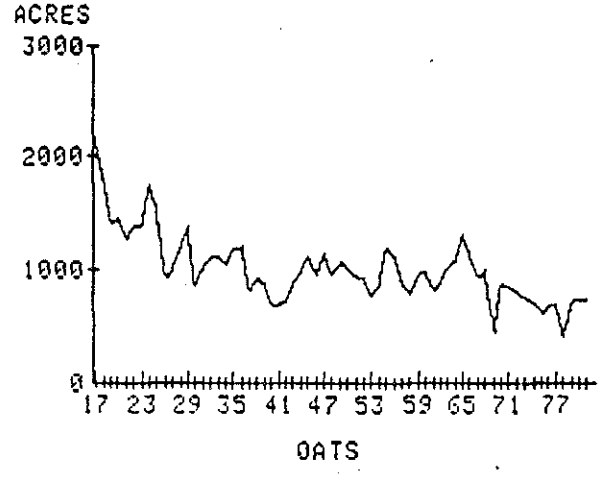
It is more meaningful to discuss cropping patterns in terms of general categories than in terms of specific crops. There have essentially been four types of crops grown on Project lands. The dominant crop type is feed grains and forages. Included in this category are such crops as barley, corn grain, oats, corn silage, alfalfa hay, pasture, and other hay. The historical acreages of these crops are shown in Graphs 4 and 5. In general, these graphs indicate that Project farms mirrored trends existing throughout Utah agriculture. Livestock production and associated farming practices have come to predominate in Utah agriculture because the State has demonstrated a comparative advantage in livestock related industries. The only exception to this trend has been in the production of fruits where Utah products are very competitive in Southern states, like Texas and Arizona.

The second major type of crop is food grains, notably wheat. Wheat acreage has declined steadily since 1935. (See Graph 6.)

GRAPH 4
FEED GRAINS, CORN, BARLEY, OATS

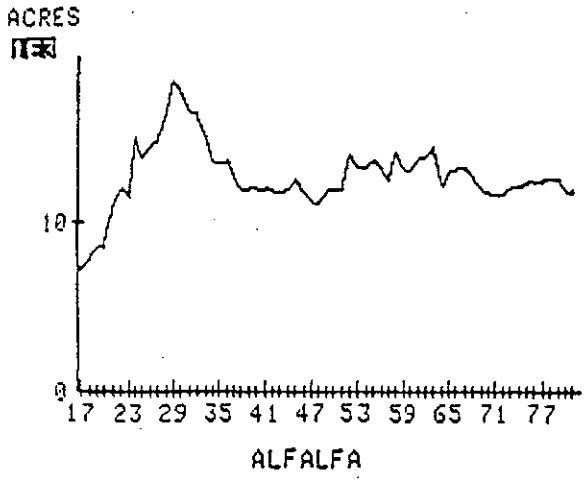


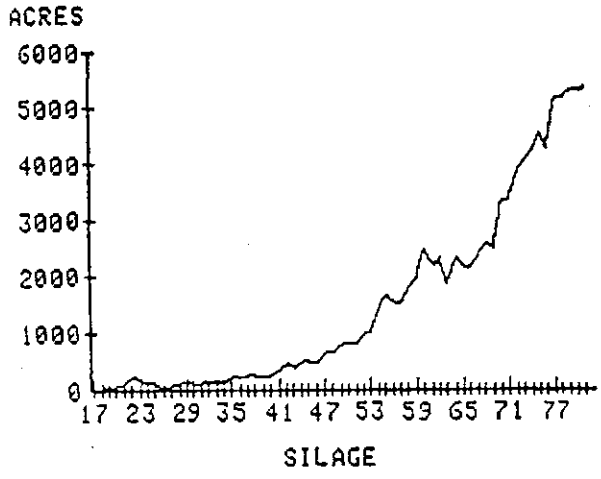


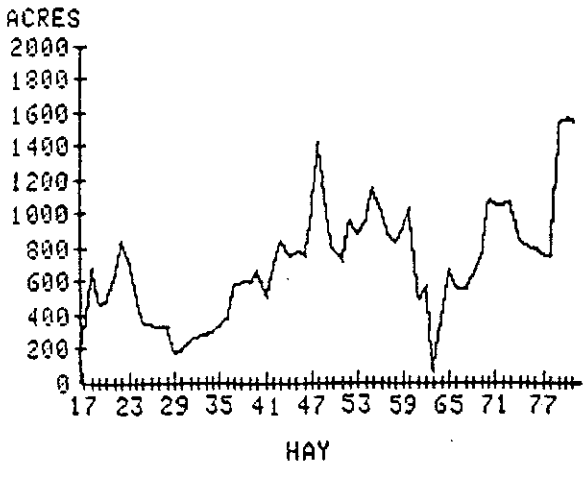


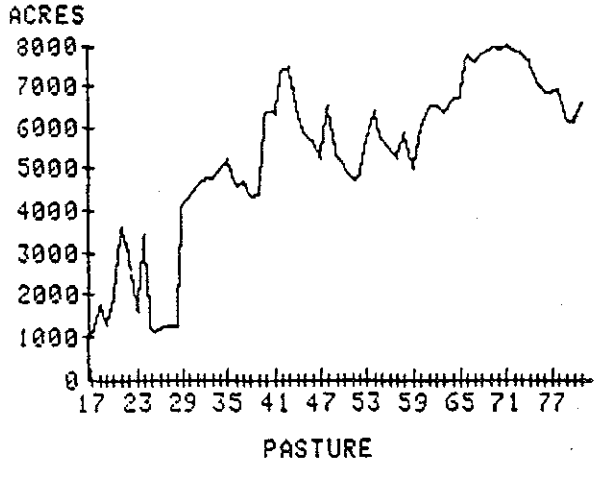
Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1917-1980).

GRAPH 5
FORAGE CROPS, ALFALFA, OTHER HAY, PASTURE



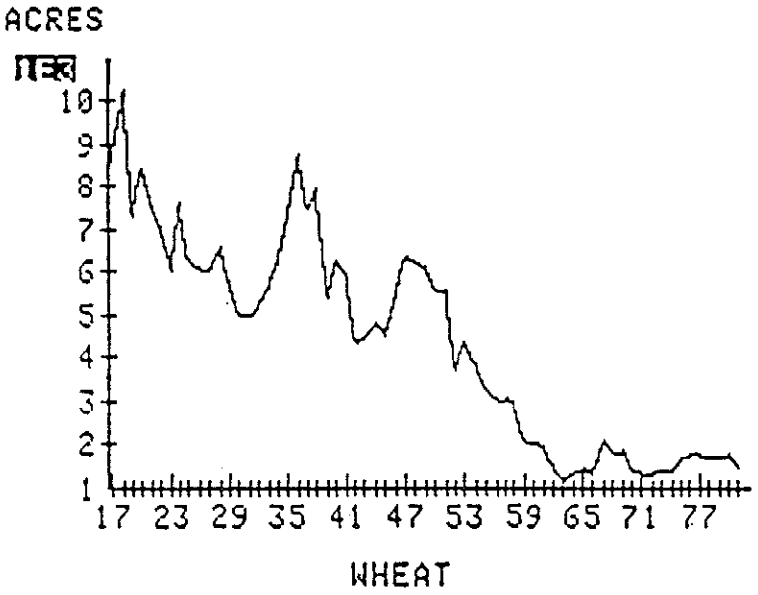






Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1917-1980).

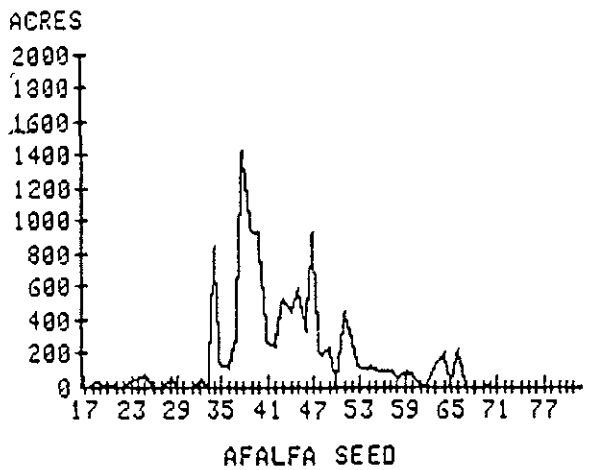
GRAPH 6
WHEAT PRODUCTION



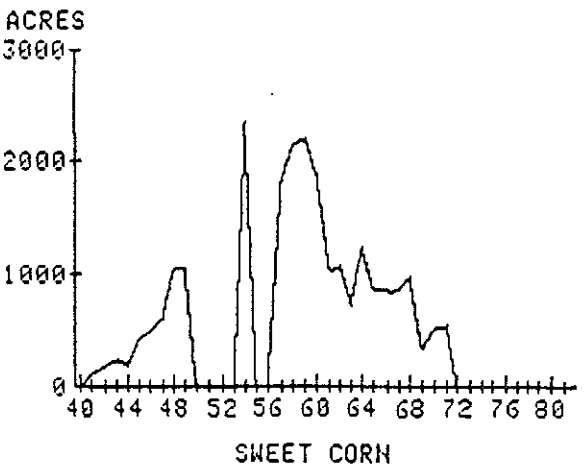
Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1917-1980).

The third crop type is specialty crops such as onions, tomatoes, sweet corn, peas, canning beans, potatoes, alfalfa seed, gardens, and sugar beets. (See Graphs 7, 8.)

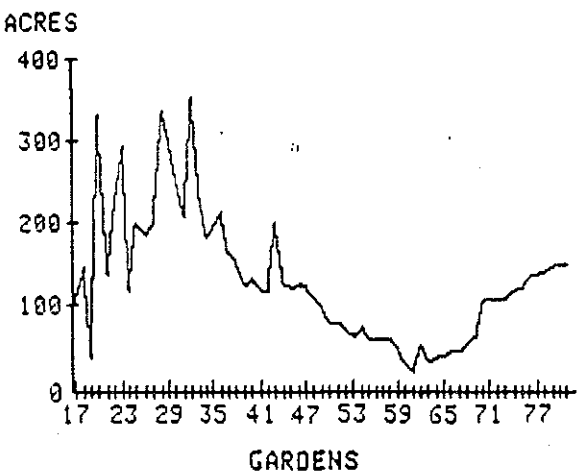
GRAPH 7
SPECIALTY CROPS



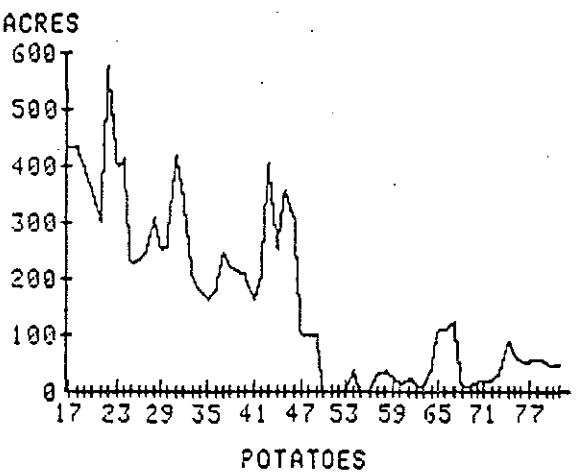
AFALFA SEED



SWEET CORN



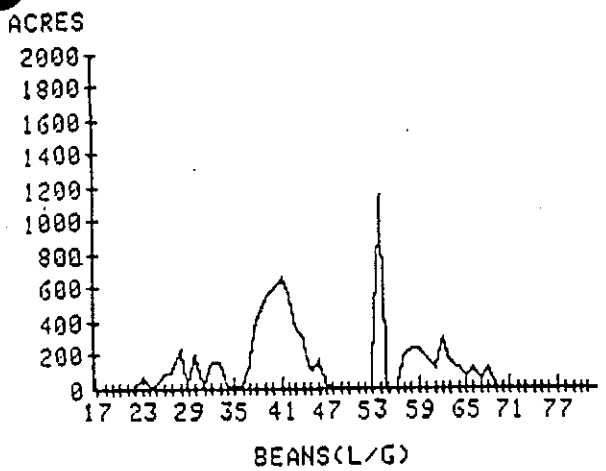
GARDENS



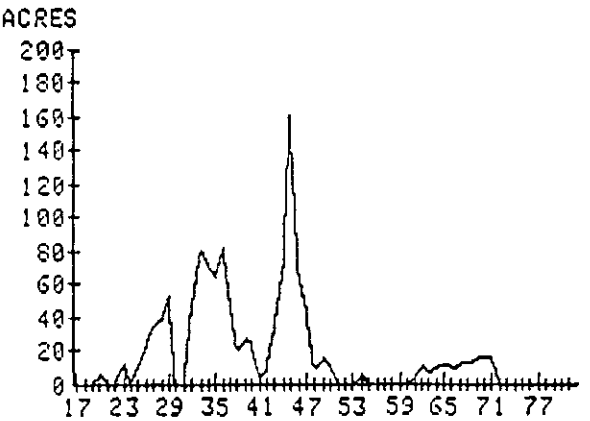
POTATOES

Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1917-80).

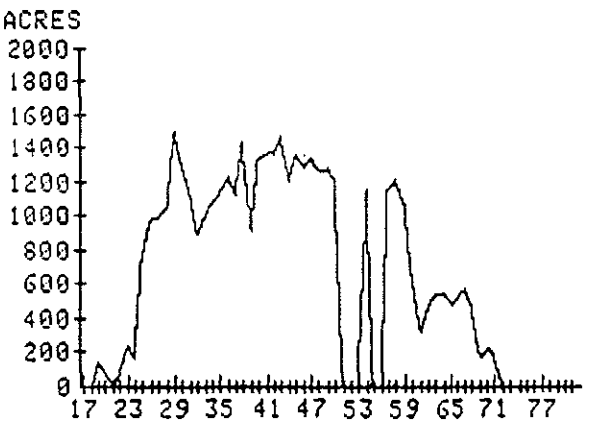
GRAPH 8
SPECIALTY CROPS



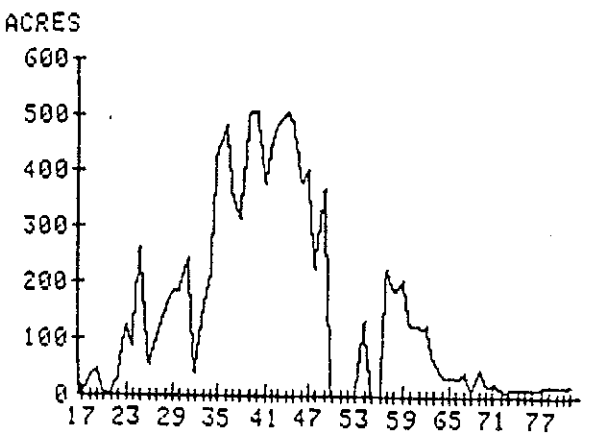
BEANS(L/G)



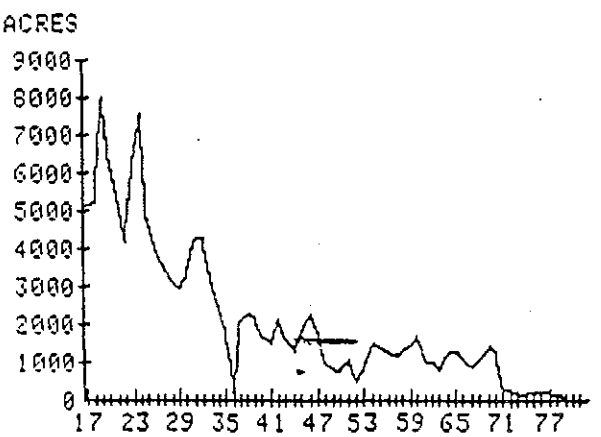
ONIONS



PEAS



TOMATO



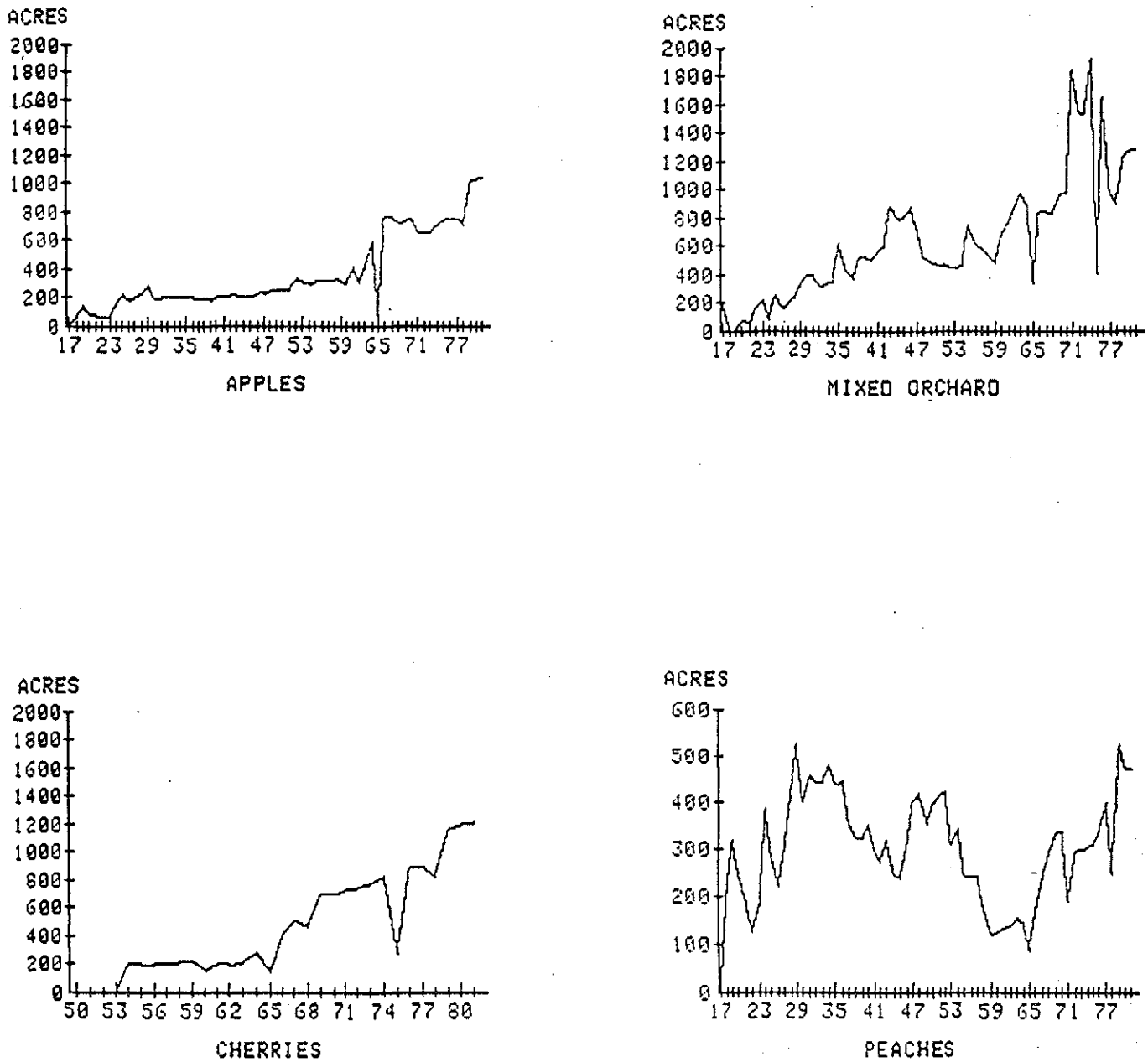
S.BEETS

Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1917-1980).

While some of these crops had been planted since the beginning of the Project, the height of specialty crop plantings was the 1940`s and 1950`s. A gradual reduction has occurred since that time.

The fourth crop type is fruits. In general, fruit acreage has increased since the inception of the Project. (See Graph 9.) The most dramatic increase has been in the acreage devoted to sweet and sour cherries, but apples have also shown a steady increase.

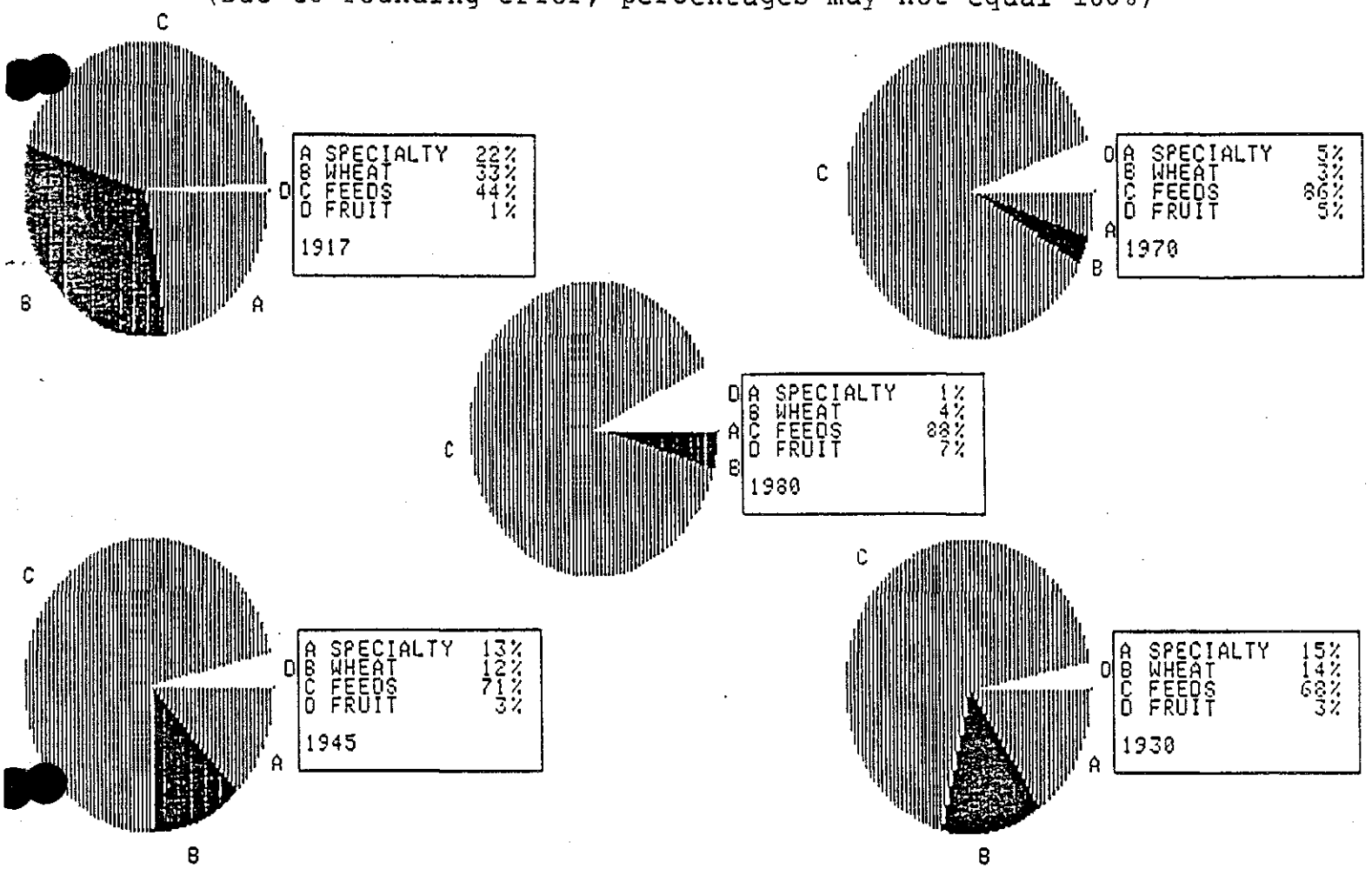
GRAPH 9
FRUIT ACREAGE



Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1917-1980).

Graph 10 shows changes in cropping patterns. Since 1917, the decline in acreage devoted to specialty crops and wheat, has been offset by a dramatic increase in acreage committed to feed grains or forages. There has been a steady increase in fruit acreage, as well. Many of the facilities employed in the processing of Project specialty crops, such as vegetable canning or sugar beet processing plants, went out of business in the early 1970`s, about the same time final payments were made on the Project. Pressure from the Project repayment cost may have kept many of the specialty crop growers and processors in business long past the time when they were no longer competitive with major agricultural centers such as California. Fruit growing costs, however, were competitive with major centers like Washington State, and Utah growers were able to capture markets like Texas and Arizona where they had a transportation cost advantage. These plants might also have closed for a number of reasons, among which is the lack of capital reinvestment that eventually made them obsolete.

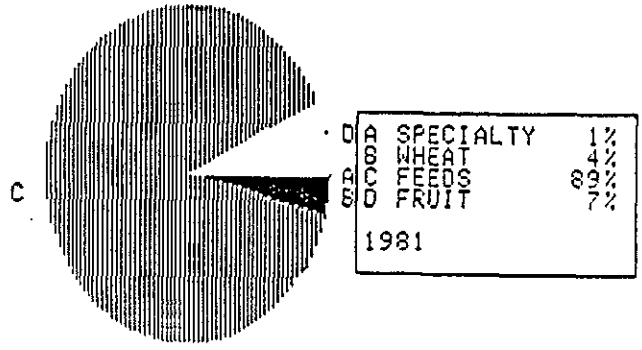
GRAPH 10
PRODUCTION SHARES OVER TIME
(Due to rounding error, percentages may not equal 100%)

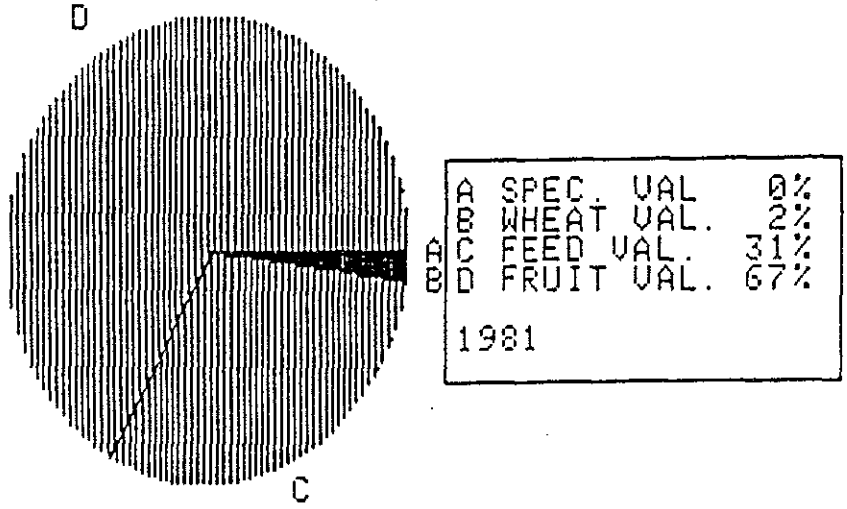


Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1917-1980).

Graph 11 compares the current number of acres planted in each category with the current market value (1981). While there's a major portion of project acreage planted in feed crops (89%) a majority of project income derives from sales of fruit.

GRAPH 11
A COMPARISON OF PRODUCTION AND INCOME SHARES
(Due to rounding error, percentages may not equal 100%)



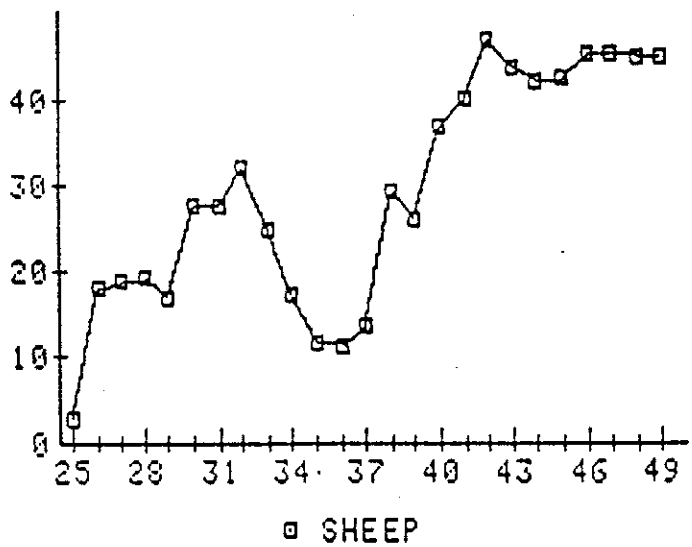


Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1917-1980).

LIVESTOCK

While not a direct product of the Project, livestock is an important part of the farms found on the Project. Much of the forage crop goes to support livestock operations of local farms which produce sheep, horses, cattle, dairy cows, and hogs. The number of animals of each type supported by Project crops has varied. Sheep numbers grew steadily through the 1940`s, then began a fairly moderate decline. (See Graph 12.)

GRAPH 12
SHEEP NUMBERS

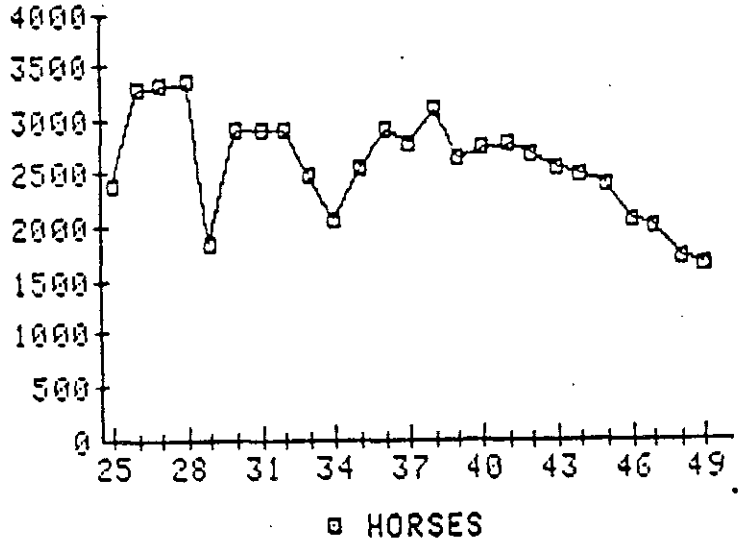


Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1925-1949).

The decline has been more of a function of national consumption patterns than Project restrictions or limitations. Sheep production declined nationwide until recently (U.S. Department of Agriculture 1981).

As might be expected with an econcomy that switched from horsepower to tractor power, the number of draft horses has declined since the early 1930`s. (See Graph 13.) Note the corresponding decline in oat acreage--a major feed item for horses. (See Graph 4.)

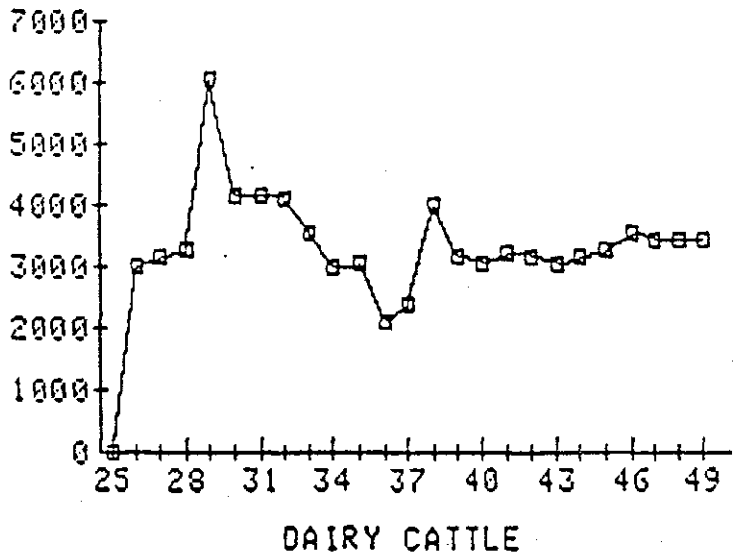
GRAPH 13
HORSE NUMBERS



Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1925-1949).

After a peak in dairy cattle numbers during the 1930`s, dairy cattle have been a fairly stable livestock commodity in the Project area. (See Graph 14.)

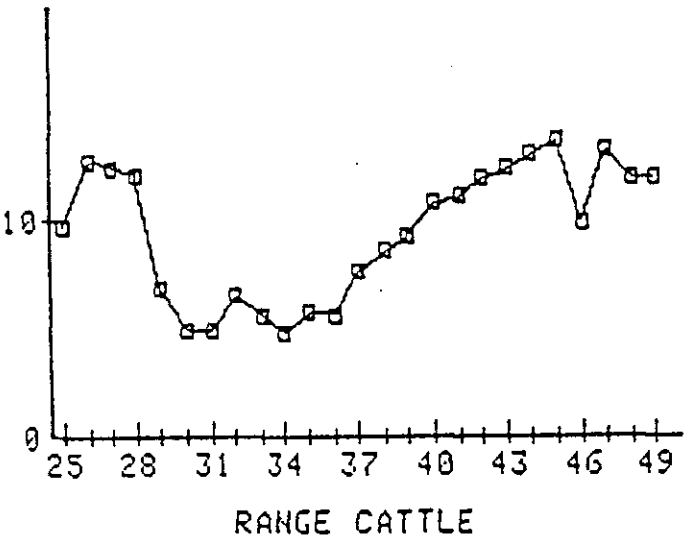
GRAPH 14
DAIRY CATTLE NUMBERS



Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1925-1949).

Range cattle numbers grew from 1934 until the mid-40's, when cattle numbers stabilized. (See Graph 15.)

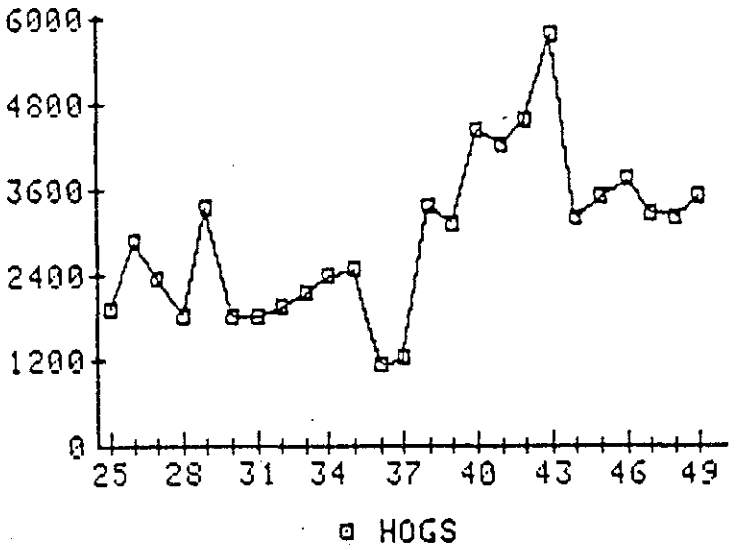
GRAPH 15
RANGE CATTLE NUMBERS



Source: (Strawberry Water Users Association Annual Project Crop and Livestock Report 1925-1949).

Hog numbers stabilized somewhat during the 1940's even though there were periods of extreme variability early in the Project's history. (See Graph 16.)

GRAPH 16
HOG NUMBERS



Source: (Strawberry Water Users Association Annual Project Crop and Livestock Reports 1925-1949).

Graphs 14, 15, and 16 show the long-term comparative production advantage of Utah livestock operations relative to other livestock production areas in the United States. Utah livestock operations are among the most efficient, and over the 70 years since the Project was built, have tended to crowd out other uses of the land which are less competitive nationally. There is a direct relationship between the lack of a decline in livestock numbers and the increased committment to feed acreage.

LAND VALUES

There were few reported prices for land, water or chattels in the early history of the area. It was not until establishment of a General Land Office in 1869 that this condition changed. Sub-sequent to that time, limited records show that the best land with water started to sell for $10 per acre.

Prior to completion of the Strawberry Project, it was assumed that a water share would cost $40.00 per acre, payable in 10 annual installments without interest. That meant that:

> ...people who can acquire lands at reasonable prices can secure a water right from the Government, and in a few years be in possession of holding which will represent values ranging from $100.00 to $500.00 per acre, according to the use to which the land is put. Concerning this statement there can be no argument...Not only this, but all subsistence must come from the land, and the farmer of today who sells his holding cheaply, or who abandons his calling for the pursuits of professional or commercial life, is leaving a business which is just entering upon its true prosperity...At present first class benchland, partly developed and improved having a flood water right (that is sufficient water for one or two irrigations in early spring), may be purchased for from $50.00 to $75.00 an acre, and first class bench or bottomland, fully improved with a good water right, may be purchased for from $150.00 to $250.00 per acre. Land values are now at their lowest under the Strawberry Valley Irrigation Project (Engberg 1915).

From 1869, land prices gradually increased until they reached a high point in 1918, when several pieces under the Project sold for $400 to $425 per acre without any improvements except for fencing and water rights. With the general price decline for agricultural commodities in 1921, land prices dropped dramatically. In 1921, the Bureau estimated that land values under the Project were:

Unimproved land without water	$50/acre
Improved land without water	$100-150/acre
Improved land with water	$200-250/acre

It should be noted, however, that the land under this project differed from land under the majority of other Bureau projects. Strawberry Project lands were almost entirely in private ownership and in cultivation for a number of years before the Project was constructed; therefore, the estimates of land values are just exactly that--estimates. Little land traded hands during the 1920's. By 1924, land valuations on the Project had depreciated to 1915-1916 levels. In that year, the Bureau calculated land values as:

Unimproved without water	$20-35/acre
Improved land without water	$75-150/acre
Improved land with water	$150-250/acre

Tax revenue collections decreased through lowered assessed valuations for the first time since 1915. These lower taxes, however, did not materially assist the United States in the collection of the current or past due construction and operation and maintenance charges. Everyone assumed that land values would bottom out in 1924, but prices continued to fall through 1926 until the best Project land sold for only $150 per acre. Land values did not reach 1918 levels again until World War II.

MARKETS

No commodity will be produced without a market. In 1915, the Strawberry Water Users Association published the following description of the market potential of the area.

> The most helpful feature of all is the market outlook, and this fact, of all, is the most important. There is probably no other agricultural district in the United States where a more natural and permanent outlet is at hand than the lands under the Strawberry Irrigation Project. The Denver & Rio Grande Railroad and the San Pedro, Los Angeles and Salt Lake Railroad traverse the valley east, west, north and south. These lines reach Nevada and California points, the Northwestern coast, and the Eastern markets.
>
> Utah Valley barley is disseminated in every direction, and a larger quantity of this product is shipped from the vicinity of Spanish Fork and Payson than all the remainder of Utah grain districts combined. Three hundred thousand bushels is our modest record for 1908.
>
> The local sugar beet market, and the hay and grain market are established certainties at highest valuations. The fruit and vegetable demands are always a great deal in excess of the supply, and this mainly on account of the close proximity to the greatest mining districts in the West. The great Tintic mineral belt,

encompassing the cities of Eureka, Mammoth and Silver City, lies just 30 miles to the west. Directly to the east and southeast, 30 to 40 miles,are the world celebrated coal mines, Castle Gate, Scofield, Winter Quarters and Sunnyside. Forty miles to the northeast is the gold and silver camp, Park City, and over to the northwest, the same distance, we have the copper mines of Bingham and Mercur. Salt Lake City is located 60 miles due north.

From this, it can be plainly seen that Utah Valley is in the very heart of markets that are easily attainable. The mining market, furthermore, is the highest priced market known. A great many growers of garden truck save transportation charges by hauling their produce to the mining camps with teams, the produce is jobbed to the retailers for spot cash. Others go into the business of hauling and peddling these goods for profit, they also buy the eggs, poultry, veal, mutton and beef. The trips are easily made because the wagon roads are well built and are passable every day of the year.

The growth of the towns within the Strawberry Project will constantly increase the demand. With necessary labor applied, all crops will bring profit.

There will be no results without effort. The soil will not yield big returns here without being properly worked, anymore than it will elsewhere, and the sweat of one`s brow is the price of a bank account. The soil will respond with gratifying liberality, though, to the hand of the energetic tiller.

The sheep and cattle industry is carried on under an extensive and profitable system. The hills and mountains supply an almost unlimited area for summer grazing, and in the winter thousands of cattle are brought down into the valley and fed, thus enabling the farmers to get the best prices for their hay (Engberg 1915).

Once the Project was underway and producing crops, other views surfaced. The key to distant markets was the railway. Perishable products, such as fresh fruit and vegetables, could not be shipped far profitably.

Markets and Transportation. The Project area is traversed by two transcontinental railway systems and one interurban railroad connecting the several Project towns with Provo, Salt Lake City and Ogden. The D&RGW Railroad connects the Project with the coal camps of Carbon County, Colorado and the East with a branch line to the Tintic mining district. The Los Angeles & Salt Lake Railroad (Union Pacific System) connects with

points in Southern California as well as Eastern and Midwestern points through the Ogden gateway. The Salt Lake and Utah Interurban Railway is the local road used for travel and transportation between the several Project towns. All these railroads have numerous stations and shipping points with loading facilities advantageously located over the entire Project. About 25 miles of paved highway have been constructed between the several Project towns connecting with State highway to Provo and Salt Lake City. The main State highway traverses the entire project from Santaquin on the south to Springville on the north. Other main traveled roads are graded and graveled and sufficient in number to facilitate transportation. For these reasons, the costs of loading and transporting agricultural products to market form a small item. The cities of Salt Lake, Ogden and Provo and the mining towns of Mammoth, Eureka, Silver City, in the Tintic mining district on the south and Price and other coal mining towns in Carbon County on the east, furnish markets for the consumption of some of the agricultural products raised on the Project, such as vegetables, fruit, poultry, butter and eggs. Fruit, poultry, butter and eggs are, however, shipped mostly to far Eastern points such as Chicago, St. Louis, and New York, and livestock generally to Southern California points. Through freight rates to Eastern markets are almost prohibitive. This is one of the main barriers to successful marketing of agricultural products raised on the Project. Hearings before the Interstate Commerce Commission in regard to high freight rates within the Intermountain districts are now being held, and it is hoped that favorable action on this all important matter will be taken, and appreciable reduction in freight rates within this district and to eastern markets established. Nearly all fruit is shipped to large dealers through local cooperative associations. Because of the distance from market and the present high cost of transportation by rail, the water users of the Project are realizing that shipment of anything but manufactured products of the farm is a nonpaying proposition and gamble. This is borne out by the steadily increasing number of poultry, dairy cattle, hogs, lambs, turkeys, etc., raised for consuming surplus and waste products as far as possible (Strawberry Valley Project Annual History 1925:79-81).

COOPERATIVES

There were also problems with the cooperative marketing entities.

Cooperative Marketing. There are altogether about ten cooperative marketing associations functioning on the Project. Practically all have been organized within

> the last 2 or 3 years. Some of these associations are doing good work, others are lying dormant. It is believed that two or three associations organized along special lines could readily handle the entire project area, rather than the present number. The tendency has been to organize the growers of each special crop. This requires a diversified farmer to become a member of several associations with a corresponding increase in general overhead expense and fosters the support of many weak organizations, instead of several large active associations capable of handling throughout the year practically all crops produced in the Project area (Strawberry Valley Project Annual History 1925).

Given the problems associated with the marketing of specialty crops and "food" items and the decline in "area" mining activity, it is not unusual that over time more acreage went into the production of feed items.

IX. GRAZING

The area surrounding the prospective site of the Strawberry Reservoir was considered an excellent grazing area, and had been used extensively prior to the Project. However, in 1905, the Reclamation Service District Engineer, George Swendsen, cited poor range conditions in the Strawberry Valley and Spanish Fork River basin due to overgrazing and suggested that management of the Strawberry River watershed by the Reclamation Service might be necessary. (Strawberry Water Users Association Grazing Leases, Permits, and Correspondence 1906).

Revenue from grazing provided a significant contribution toward the payback on the reservoir and related works. The land surrounding the current site of the reservoir had belonged to the Ute Indians until withdrawn in 1907 and purchased in 1910 for the Strawberry Project. The 1914 Strawberry Valley Project Annual History, describes these grazing lands:

> In connection with the storage works for the Strawberry Valley Project, the Secretary of the Interior withdrew from all forms of entry 60,160 acres of land located within the drainage area of the Strawberry Reservoir, and covering all the ground that is occupied by the several structures. Approximately 8,000 acres of this area will be covered by water when the reservoir is full. This land is located within the Uintah National Forest in the Wasatch Mountains at an elevation of 7,500 feet and has considerable value as a range.
>
> To get the maximum use out of it, it was decided during the earlier part of the year 1907 to lease the grazing privilege to the highest bidder. This was accordingly done, and from that time to the present date the grazing privilege has brought in approximately $10,000 per annum.
>
> When Congress passed the Indian Appropriations Act in 1910, grazing became an important part of Strawberry Project revenues. Previous to the passage of this Act, the income from the leasing of the land, less the cost of maintenance and operation, was paid to the Indian Department, but since April 4, 1910, the income has been credited to the Strawberry Valley Project. This land is at present being leased for the grazing of sheep, under two leases, one covering 51,840 acres and the other covering an area of 8,320 acres. The total number of sheep allowed to be grazed under the leases being 29,000. The income from this grazing land since the Reclamation Service began leasing it in 1907, is as follows:

Year	Disbursements	Receipts
1907 - Rentals		$10,408.00
1908 - Indian Office		1,030.00
1908 - Indian Office*	$ 8,728.00	
1909 - Rentals		10,600.00
1910 - Rentals		10,600.00
1910 - Indian Office*	9,945.88	
1911 - Rentals		10,254.00
1912 - Rentals		10,254.00
1913 - Rentals		10,232.00
1914 - Rentals		10,232.00
1914 - Refunds**	1,997.77	
	$20,671.65	$73,610.00
		20,671.65
TOTAL REVENUE TO DATE		$52,938.35

*Income less O & M charges, paid to the Indian Office
**Refund made to present lessees to cover lands submerged by rising reservoir.

From the above table it will be noted that income from land is a substantial asset, and will be a great help in offsetting the maintenance and operation charge on the Project. The maintenance and operation of this feature is not expensive, as one range rider who is paid a salary of $90 per month and furnishes his own saddle horse, feed and subsistence, does all the necessary inspection work, counting of sheep, etc. during the 7 months of the year that the land is used for grazing.

The grazing privilege is chiefly valuable to the sheepmen on account of it being available as soon as snow goes off the ground in the spring for lambing, and can be occupied until snow comes in the fall, which is a considerable time after the sheep have to leave the National Forest.

These grazing leases are now being leased in two parcels, one containing an area of 41,840 acres to E. Bushman, Jr., T. J. Chipman, and Adamson Bros., the consideration being $9,126 per annum. The other parcel containing 8,320 acres is leased to Austin Bros. Association and George A. Smith, the consideration being $1,160 per annum. The area leased to E. A. Bushman

Jr., and others includes the land covered by water in the Strawberry Reservoir, and a supplement to this lease provides that the lessees have been rebated pro rata for the area covered by the water, and during 1914 the amounts rebated for the submerged land was $1,170.50, there being approximately 1,650 acres under water.

During 1914, there were 140,345 sheep grazed on the entire area leased. The following table gives the number of sheep grazed on each parcel during each month of the grazing season.

NUMBER OF SHEEP GRAZED BY PARCEL, BY MONTH, 1914

Month		51,840 acres	8,320 acres
May	1914	19,572	3,950
June	1914	22,972	3,975
July	1914	14,888	1,528
August	1914	14,978	1,528
September	1914	20,228	2,525
October	1914	23,572	2,695
November	1914	7,937	
TOTAL		124,147	16,198

Source: (Strawberry Valley Project Annual History 1914).

In 1915, the land surrounding the Strawberry Project was once again leased for $10,232 under previous contract arrangements with the same parties. Of that amount, $1,285 was refunded to lessees to cover lands submerged by the rising reservoir. When this contract expired at the end of the 1915 grazing season, new bids were received that ranged from $14,650 to $9,125 on the larger tract and $2,100 to $1,109 on the smaller tract. While new contracts were not written in 1915, the leases were awarded to the highest bidder. The average monthly range use-rate for 1915 on each of the tracts was 20,562 sheep per month on the large tract and 3,856 sheep per month on the smaller tract (Strawberry Valley Project Annual History 1915).

On January 21, 1916, Albert Jones, Assistant Secretary of the Interior, signed a 5-year contract with the Heber Horse and Cattle Growers Association of Heber, Utah and the Wallsburg Livestock Association of Wallsburg. Utah, covering the Strawberry Project grazing lands. The first contract was for $14,250 per year less a rebate for water-covered lands, which entitled the lessee to graze 51,840 acres. The second contract was awarded for $2,100 per year for 8,320 acres. Both the Heber and Wallsburg Companies were required to provide a bond. They were allowed to graze horses, cattle, and sheep from May through the

first part of November. The average number of grazing animals comprised 81 horses, 934 cows, and 14,572 sheep. Net grazing proceeds for 1916 were $13,923.95, since the Association paid for a range rider and for the hands necessary to drive the livestock up to the grazing lands.

By 1921, accumulated net revenue from grazing leases exceeded $104,000. Net revenue for 1921 alone was $15,944. Some of which represented money the Bureau had paid under arrangement to the Association for submerged lands. With 1923 net grazing revenue more than $15,000, the accumulated net grazing revenue had reached $145,341. There were 12,076 cattle-months 78,129 sheep-months and 1,050 horse-months were grazed on lands associated with the Project in 1923. As had been done in the past on a limited scale, some of the forested lands surrounding the Strawberry Reservoir were cut and sold in 1923. There is little to indicate that this was done on a large scale.

Since 1926, the High Line Canal Company or "Strawberry Grazing Company" has managed the grazing leases. In 1929, the Association opened the lands surrounding the Reservoir to grazing applications. They received applications to graze over 100,000 head of sheep that year, a large part of which came from members of the Association. The carrying capacity only allowed 25,000 head. Because of this oversubscription, the Association agreed to provide allotments only to its members, based on the number of acre-feet of water owned. For sheep, they were allowed 1 and 1/2 sheep for each acre-foot of Project water.

In an economic context, this obviously increased the value of the water right associated with the Project. While it may have been an equitable method for allocating rangelands, it allowed unearned rents to accrue to Project farmers. In essence, it facilitated a concentration of wealth, where the rent was capitalized into the value of the water right which, in turn, was capitalized into the value of farmer-owned lands. This is similar to the situation that occurs in the public rangelands administered by the Bureau of Land Management where the value of the leased rangeland becomes capitalized into the value of the farm or ranch property. In the case of the Strawberry Project, this range "right" could be transferred only when the water right and lands were bought and sold. Obviously, this improved the wealth position of those who had originally contracted with the United States for water; however once the first sale of the water and associated privileges occurred, there was no further capitalization of rent by subsequent owners. That is, the lease "rent" accrued to the original land and water owners only, assuming there were no further changes in the benefits accruing to the holders of Strawberry water rights.

After the Central Utah Project was authorized, with its planned enlargement of the Strawberry Reservoir, the Association recognized in the 1960`s that some of the grazing land would be lost. On November 29, 1973, the Association filed suit against the United States for compensation for future grazing losses

since any change in land size might cut the Association's earnings. Preliminary discussions with the Bureau of Reclamation failed to yield agreement on the amount of losses (Strawberry Valley Project Annual History 1966-1975).

The Association has provided an estimation of a fair market value for the loss of grazing to the Association. (See Table 9.) The estimates provided in Table 9 are preliminary estimates only, and final fair market values are currently being negotiated between the Bureau of Reclamation and the Association. Recent work by Nielsen (1982), tends to support the Association in their estimation of a fair market value. A payment based on some aggregated measure of previous grazing charges very well could underestimate the value of the grazing if those charges were subsidized by the Association because it could not legally pay a dividend due to its form of business structure. As a result of the legal structure of the Association, the rates at which the grazing land was leased cannot be considered a measure of value. The issue of grazing will continue to be an important one to the Strawberry Water User's Association as well as to the Bureau of Reclamation.

TABLE 9
STRAWBERRY VALLEY PROJECT - 1910 ACT LAND
ESTIMATED FAIR MARKET VALUE FOR THE LOSS OF GRAZING TO THE STRAWBERRY WATER USER'S ASSOCIATION
RECLAMATION TAKING (13,550 ACRES) ALLOWING NO GRAZING EXCEPT ON LEASE

Area	Total Acreage	Grazed (Avg.)	Average AUM's	Area Rating	Area Taking	AUM's Carrying Cap.	Value Per AUM	Yearly Total For Taking	
Mud Creek	1,704.0 * 600.0	172 cattle	860.00	2.33 ac/aum	1,188 acres) * 600 acres)	638.62	$7.50	$ 4,789.65	
South	11,893.6 * 564.0	1,148 cattle 685 calves	6,596.25	1.84 ac/aum	6,147 acres) * 564 acres)	3,494.02	7.50	26,205.15	
Big Meadow	3,132.0 *1,988.0	688 cattle 406 calves	3,947.50	1.04 ac/aum	2,616 acres) *1,988 acres)	3,471.15	7.50	26,033.63	
Coop	15,456.5	5,033 sheep 4,311 lambs	6,198.13	2.49 ac/aum	45 acres	18.07	7.50	135.53	
Steer Pasture	2,711.5	647 cattle (steers)	3,235.00	.83 ac/aum	54 acres	65.06	7.50	487.95	
#6 - Non Breeding	5,238.6 * 338.0	619 cattle	3,095.00	1.74 ac/aum	2,758 acres) * 338 acres)	1,682.18	7.50	12,616.35	
#7	5,191.3	1,066 sheep 931 lambs	1,317.62	3.93 ac/aum	136 acres	34.60	7.50	259.50	
#8 and #9	3,301.7	1,016 sheep 883 lambs	1,254.64	2.63 ac/aum	606 acres	230.41	7.50	1,728.08	
	48,629 acres *3,490 acres				13,550 acres *3,490 acres	9,634.11		$72,255.84 - 11,471.25 $60,784.59	Gross O&M Grazing Expense .75 per acre Net

Present worth of $1.00 per annum compound interest valuation premise (Inwood coefficient) - 6% for 100 years (Factor 16.617)

60,784.59 x 16.617 (factor) = 1,010,057.00
Rounded = 1,010,000.00

*Area between maximum and minimum water surface of existing reservoir.

Source: (Nielsen 1982).

Although grazing revenues were not considered in the original payback plans devised by the Bureau, grazing has been a significant income source. (See Table 10.)

TABLE 10
GRAZING REVENUE AND COST

Year	Revenue	Cost
1970	35,627	34,371
--	--	--*
--	--	--*
1973	57,283	45,412
1974	77,778	43,431
1975	73,692	54,175
1976	77,198	72,782
1977	76,900	42,541
1978	93,019	45,702
1979	88,091	49,479
1980	95,368	50,471

*Missing Data

Source: (Strawberry Water Users Association 1970, 1975, 1981).

Without earnings from grazing lands, and other services such as power, and recreation, it is questionable if the Project could have been paid for. The Bureau has apparently recognized this, because recent projects have explicitly included other benefits such as power, recreation, etc.

X. ELECTRICAL POWER

Bureau engineers originally built the Powerhouse solely for construction purposes. Spanish Fork, however, applied for power in 1909 and most of the Project towns followed soon after. In 1911, Payson applied for power and moved immediately to secure a franchise from the county and the right-of-way for the new line. By 1914, the electrical facility was operating continuously under the increased demand, but the efficiency was still rather low because the commercial load consisted mostly of a peak lighting load for 3 to 4 hours every evening. The Bureau made a major engineering change that year anyway, and converted the generator parts from cast iron to steel. Six employees were needed to operate and maintain the power facility--one assistant electrician, four plant operators and one laborer. The plant eventually furnished power to most of the cities associated with the Project.

TABLE 11
RECEIPTS FROM ELECTRICAL POWER - 1914

Month	Spanish Fork	Payson	Salem	Indviduals
January	$ 225.00	$ 318.50	$ 60.00	$ 3.15
February	225.00	254.75	60.00	3.06
March	225.00	310.25	60.00	3.00
April	225.00	299.50	60.00	3.00
May	225.00	308.50	60.00	3.24
June	225.00	282.00	60.00	3.00
July	225.00	312.50	60.00	3.00
August	225.00	320.00	60.00	4.32
September	225.00	315.00	60.00	4.50
October	225.00	326.00	60.00	3.78
November	236.64	329.00	60.00	3.24
December	273.60	337.50	60.15	4.05
TOTALS	$2,760.24	$3,713.50	$720.15	$41.34
Total Receipts:	$7,235.23			

Source: (Strawberry Valley Project Annual History 1914).

In 1915, the general efficiency of the system remained low due to the continued deficient demand for electrical power, but a small but significant increase in commercial power occurred. The Powerhouse operated at a loss just as it had since its construction, although the loss was smaller than recorded for any previous period. Once again, in 1916 the efficiency improved slightly due to an increase in commercial demand. The Bureau made a determination that year not to lease the Powerhouse, and a campaign was undertaken to expand the number of customers. Several possibilities were explored, including trying to secure

Utah-Idaho Co.'s new plant near Spanish Fork. The sugar company, however, was under a limiting contract with Utah Power and Light Co. (UP&L) in which it agreed to purchase its electrical power from UP&L as long as its location was in UP&L service area. Through 1917, the Powerhouse had operated at a loss of $25,145.19, but by 1920, revenues were high enough to cover annual operating costs. By the mid 1920's the Powerhouse had repaid all previous losses, and showed a cumulative net gain. Electrical production grew throughout the 1920's as both commercial and private use increased. As was the case with grazing permits, electrical power was made available to those who held Project water rights.

The Spanish Fork Powerhouse needed some source of additional water supply for power purposes during the months of October, November, January, and February to handle the winter load satisfactorily and to avoid the necessity of releasing stored water in Strawberry Reservoir during the cold snaps in December and January, which would periodically reduce the natural flow of the Spanish Fork River to an almost negligible quantity for several days at a time. The options proposed at the time included:

(1) Standby contract with Utah Power and Light Co.

(2) Diesel auxiliary unit.

(3) Development of additional head of 50 feet between present tailrace and Spanish Fork River.

(4) Development in Diamond Fork Canyon of second power site for utilization of natural tunnel flow of 8 to 10 second feet.

(5) Small storage dam in Diamond Fork Canyon at the mouth of Diamond Creek.

(6) Diversion of waters of Willow Creek into Strawberry Reservoir for power and irrigation purposes.

By 1924, the Spanish Fork Powerhouse served practically all Project towns with light and commercial power. The expected natural growth of the communities gave some urgency to the development of additional power output. There was some discussion that the whole production of electrical power should be turned over to private hands. That idea was rejected since, by their own statement, they were the only competitor in the field. Additional water diversions to the power facilities were finally agreed upon.

The amount of power sold for commercial purposes had shown a slight increase over 1923, and the revenues received were slightly greater. For the year ending December 31, 1924, 1,578,310 kilowatt hours were produced (a 15.5 percent increase) and net returns were $6,170.30 (a 4.43 percent increase).

Several large businesses were either connected to the power system, or were planning to be in the near future:

(1) A beet dump was connected to the system at the Mapleton Station.

(2) A rock crushing plant was connected to the Castilla station.

(3) There were plans to build a sand and silica rock mining company to deliver rock and sand to the Columbia Steel Corporation's new plant (established in 1923).

(4) The Association was negotiating with representatives of the Utah Packing Corporation to furnish power to a large canning factory and a number of pea viner stations.

The Utah Packing Corporation negotiations succeeded and during April and May of 1926, the Bureau constructed several 5-mile power transmission line extensions. Paid for by the Corporation, these extensions furnished power to its new factory near Spanish Fork and five of the Corporation's pea threshing stations.

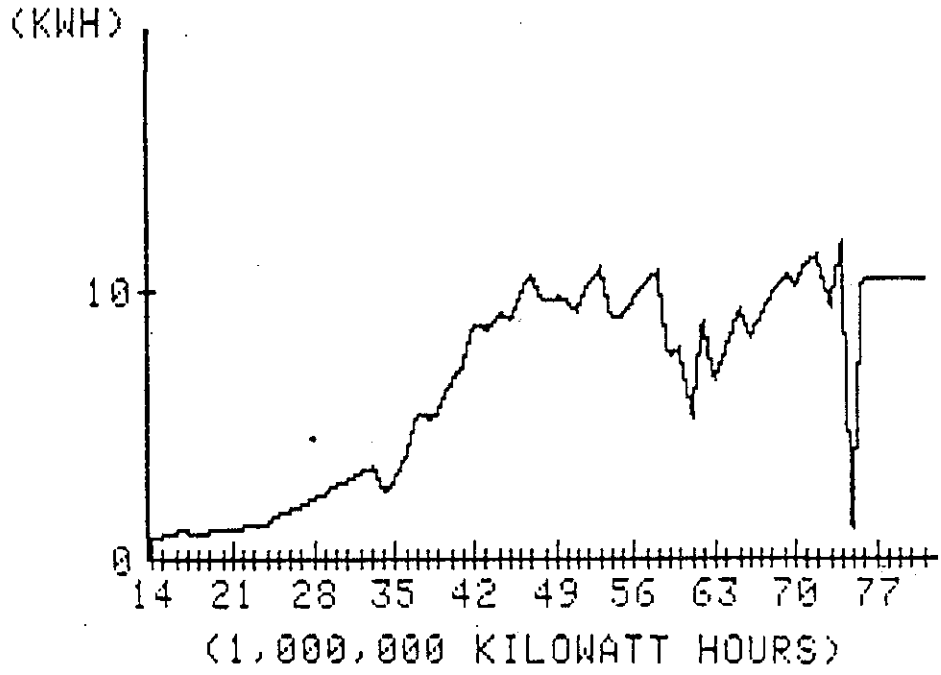
In 1926, the Strawberry Water Users Association began negotiations with the Columbia Steel Corporation to obtain auxiliary power connections with the Corporation's steam turbine generating plant at Ironton, Utah. This auxiliary load would help protect the supply of electricity to local users, make possible the extension of the Project power system, and conserve stored water in the Strawberry Reservoir. The Powerhouse had been forced to draw considerable quantities of water during the winter months to augment the flow of the river for power purposes.

In short, power deliveries increased gradually till facility capacities were met.

In 1938, SWUA constructed a second powerhouse, known as the Spanish Fork Lower Plant, with a kilowatt capacity of 250 as compared to the original Spanish Fork Powerhouse with a capacity of 900 kilowatts. In 1942, the Strawberry Water Users built another plant known as the Payson Plant, with a generating capacity of 400 kilowatts. Graph 17 provides a pictorial description of power deliveries over time from these plants. Both power plants constructed after completion of the Project, were financed solely by the SWUA.

Until 1931, the Association did not purchase any net power from outside sources. It distributed power that it generated and even provided some to other electric companies, such as Utah Power and Light Co. By 1931, however, peak demand had grown so much that SWUA was forced to make limited outside purchases. The Upper Spanish Fork Plant generated almost 2.5 million kilowatt

GRAPH 17
POWER DELIVERIES

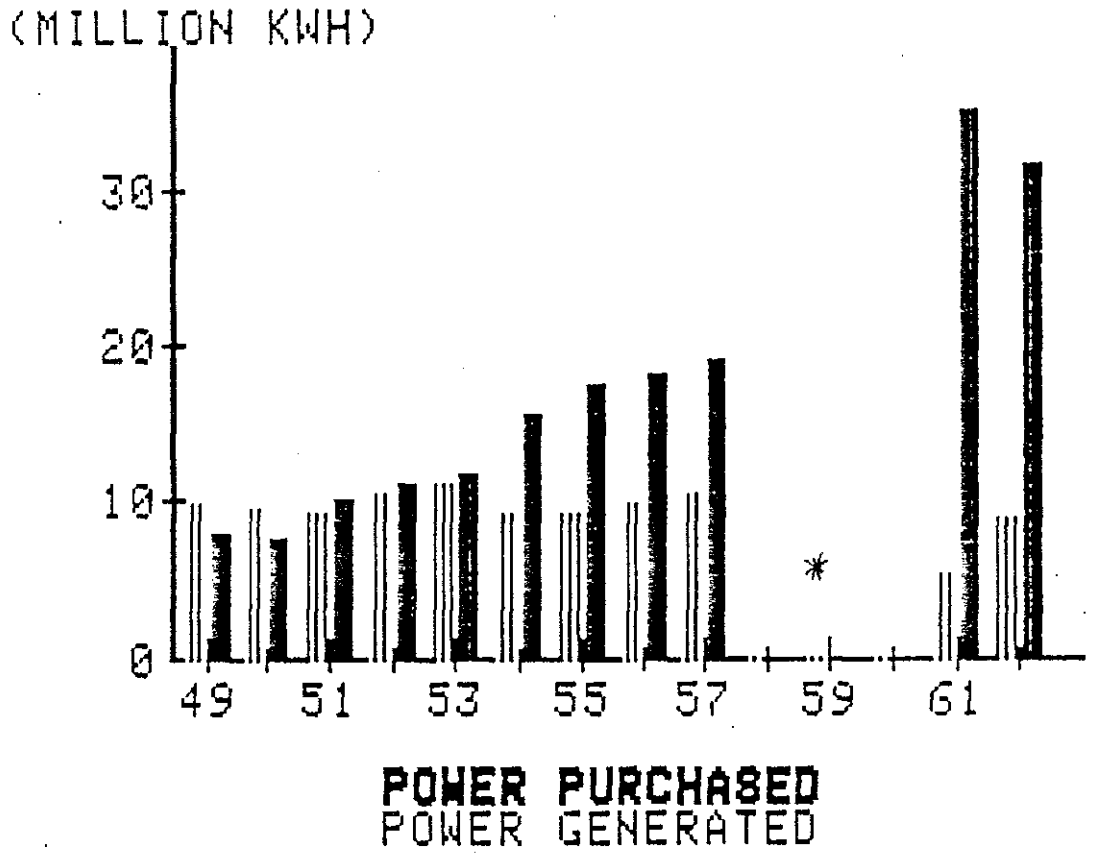


Source: (Strawberry Water Users Association Power Reports and Operation 1914-1979).

hours of electricity, but had to purchase 128,666 from UP&L and 26,910 from the City of Springville. The cost of these purchases was more than an offset, however, since in offpeak use periods the Association sold more back to UP&L and Springville than it had purchased earlier (Strawberry Water Users Association Power Reports and Operation 1931). (There were isolated instances of outside purchases prior to 1931, but not significant amounts.) The year 1951 marked the first time that power purchases from outside sources actually exceeded power generated. (See Graph 18.) At this point, the Association essentially became a broker of electrical power (Graph 19) instead of merely a generator. This was possible, of course, because of the transmission infrastructure that the Association had developed over time in normal service and expansion plans.

Power revenue did much to assist the Association in paying for the Strawberry Project--a benefit that is currently taken into explicit account on all Bureau projects where such benefits can be generated.

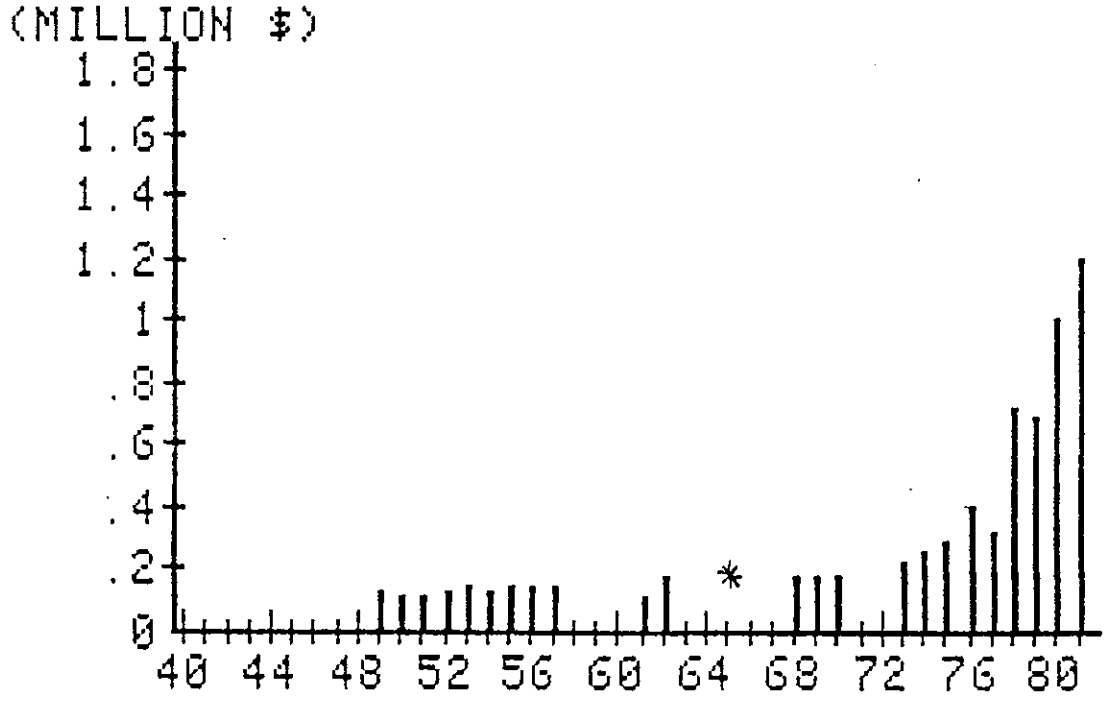
GRAPH 18
POWER ACQUISITION



*Missing Data

Source: (Strawberry Water Users Association Power Reports and Operation 1949-62).

GRAPH 19
POWER SALES



ANNUAL SALES OF ELECTRICAL POWER
(STRAWBERRY PROJECT: 1940-1981)

*Missing Data
Source: (Strawberry Water Users Association Power Reports and Operation 1949-82).

XI. RECREATION

Strawberry Reservoir is located east of the Wasatch Mountains with a view of the Uinta Range to the east and north. The mountains surrounding the valley, mostly in the Uinta National Forest, are timbered with aspen and conifers. (See Figure 92.) The climate is one of pleasant days and cool nights in the summer and long, cold winters (U.S. Department of Agriculture 1965).

There is some evidence that the Strawberry River and its tributaries were recognized as a prime trout fishery before 1906 (Royer and Dekker 1976). The first report of fishing in the actual reservoir is given in the 1925 Strawberry Valley Project Annual History, which noted that an increasing number of people visited the Reservoir for recreation and fishing purposes. The State of Utah began stocking the Reservoir with large numbers of fingerling trout and supplemented the usual stocking in 1925 by planting an additional 1/2 million salmon. During the season, 28 motorboats and 150 rowboats were licensed to operate on the Reservoir (Strawberry Valley Project Annual History 1925).

During the early years after the Reservoir had filled, the recreational potential for fishing was limited somewhat by occassional losses of fish. Somewhat high fish losses noted during the period 1927-1936

Reasons for some of the losses were given by Brigham Young University biologist, Dr. D. I. Rasmussen:

> Dr. D. I. Rasmussen cites suffocation caused by a low oxygen content of the waters as the principal cause of death to fish. During the winter, the lack of oxygen is the result of organic matter decomposition and retarded photosynthesis of aquatic plants.
>
> Strawberry Reservoir is comparatively shallow and has a large amount of organic material undergoing decomposition on the bottom of the reservoir almost constantly.
>
> In summer, stagnation results when the water becomes unduly warm, increasing the rate of organic decay by which means the oxygen is removed from the water. This stagnation period is often coupled with calm weather, with little or no wind action, resulting in little or no aeration of the water. Because of higher water temperatures, the oxygen content in the summer stagnation period need not be as low as in the winter to be fatal to the fish population. The danger of large fish loss is always greatest in the time of low water (Strawberry Valley Project Annual History 1927-1965).

1927: In the summer, about 40, 3-pound trout were found dead near the George Madsen camp.

1928: Fish were found dead, apparently from suffocation in the portal bay in August.

1929: In August, Lee Kay buried some 300 fish averaging about 3 1/2 pounds in weight, that had floated ashore.

1929-32: The number of eggs taken from the reservoir by the Utah Fish and Game Department decreased. Fishing became poor, although no signs of winter loss were evident.

1932: No fish came up the streams to spawn. On May 3, 1932, Lee Kay, Earl Clyde, and Jake Clubb made a trip around the east side of the Reservoir; they found a windrow of dead chubs 1 1/2 miles long containing as many as 40 chubs per foot. No dead trout were found. The fishing season opened, but no fish were taken so the camps were forced to close. In the fall, an attempt was made to seine fish for the State Fair, a few trout were found, and some dead trout were recovered during the seining operation.

1933: The State closed the lake to fishing. Early spring revealed some dead chubs and a few dead trout.

1934: The lake had a successful fishing season.

1935: In late April, Earl Clyde, William Whitney, and Lee Kay walked around the east shoreline and found the following dead fish: tons of dead chubs, 890 rainbow trout, 54 native trout, 4 brown trout, and 2 salmon. Fishing during the 1935 season was fairly good at times. The lake was frozen over October 26.

1936: The ice broke up May 8, 1936, after being frozen over 6 months and 12 days. Lee Kay visited the east shore in the middle of the month of May finding many dead chubs and a few dead trout. On June 26 and June 27, William Whitney, Lee Kay, and D.I. Rasmussen sampled the lake and found dead fish on the bottom.

DESCRIPTION OF FISH DEATH LOSSES (1927-1936).

Source: (Strawberry Valley Project Annual History 1927-65).

Losses occurred again in 1947.

> A few dead trout were seen near the mouth of Indian Creek early in the season. The number of dead fish was low, and the cause of their death was undetermined. At irregular intervals during the months of August and September, small numbers of dead trout were reported along the north shore of the Reservoir near the mouth of the Strawberry River. Investigations were made of each reported fish loss, but no serious loss was found. At that time, practically the entire north end of the lake was filled with aquatic vegetation so dense that the area was almost impassable to fishing boats. It is highly probable that the fish that were lost, had suffocated from lack of oxygen which had been removed from the water during the night by aquatic plants. (A Report on the Fishery of Strawberry Reservoir, Summer 1946, by George W. Tripp.) (Strawberry Valley Project Annual History 1927-1965).

In 1947, traffic counters were installed on the roads around the Reservoir perimeter in an effort to determine the number of fishermen using Strawberry Reservoir. Repeated mechanical failures of the counters, largely because of tampering by fishermen and children, made the results obtained completely unsatisfactory. Recreation visitation records, which are available back to 1958, indicate a steady increase of recreation visitors from 30,000 in 1958 to 86,750 in 1965, except in 1961 when the water level was at a record low and 1962 when the Reservoir was closed to fishing following water treatment to poison trash fish.

There have been a number of management problems with the Strawberry Reservoir.

> Recreation administration of Strawberry Reservoir probably began in 1926 when the Strawberry Water Users' Association assumed administrative control of the Strawberry Project. The Association is a form of mutual water company, which contracts wth the Bureau of Reclamation to repay the costs of construction, operation, and maintenance. Because recreation is obviously not intended to be the major purpose of such an arrangement, administration of recreation at Strawberry cannot be equated with the management or planning of the recreation resource at the Reservoir. Recreation development of Strawberry Reservoir has thus evolved in an unplanned manner from the very outset. The present recreational facilities complex surrounding the Reservoir reflects a pattern of development that has evolved over 50 years of recreation adminstration under this system, which essentially involves arranging leases to private recreation enterprises and collecting entrance fees from recreational users.

There are problems inherent to any situation where a large number of recreational users encounter a recreation complex developed in the above manner. These problems seem to be characteristic of some Bureau of Reclamation reservoirs where the recreation administrative responsibilities are either shared between the Bureau and another agency or are the sole responsibilites of another agency. On many Bureau reservoirs, the recreation function has been given to State recreational agencies, and the record of State management of the Bureau's recreational resources is mixed. When water user associations and irrigation districts have assumed a recreation jurisdiction, the record is clear. In these cases, the recreation resource's potential is not fully served, and facility development is usually unplanned. The situation of Strawberry Reservoir is strongly reminiscent of the latter case. The problem and it various solutions are well recognized...

From another perspective, the situation at Strawberry Reservoir is indeed unique. Because the reservoir is to be enlarged as part of the Central Utah Project, the existing pattern of recreational facility development will be altered. Enlargement will not destroy the recreational attraction of the Reservoir; rather, it will enhance its attractional attributes. Enlarging the Reservoir thus offers the first new opportunity for recreational management since the Reservoir was impounded. Solutions to the jurisdictional problem must be found, however, or the opportunity will be lost. Whatever the jurisdictional remedy, planning for recreational use and development must occur prior to expansion of water surface and shoreline perimeter (Royer and Dekker 1976).

NUMBER AND TYPE OF USERS

There are some unique features of the recreational use pattern shown at the Reservoir.

Number of Users. Strawberry Reservoir has long been portrayed as one of the most highly used flat-water fishing resources in Utah. Its notoriety as a high-use reservoir is well deserved--this reservoir probably receives more recreationists on the opening day of fishing season than any other impoundment in the State. It has been generally believed that during the remainder of the season, the total number of fishermen and other water-oriented recreationists encounterd at the Reservoir on an average day would equal or exceed the average day use at other water bodies. Casual observations and press accounts of visitor use contribute to this impression that Strawberry Reservoir receives unusually heavy visitor use.

Unfortunately, the lack of definitive historical use data for Strawberry Reservoir precludes comparisons with other Utah waters, and even if the Strawberry data were available, sporadic and inconsistent accounting procedures at other reservoirs and lakes would discourage historical comparisons. For example, use data are available for the Utah State Parks that provide recreational entry to various lakes and reservoirs. These statistics inherently underestimate use at any water body where access other than the state park is available. We doubt that an accurate scenario of past use can be reconstructed for Strawberry Reservoir. Any such depiction of use would of necessity be an educated guess.

This situation emphasizes the need to establish baseline data for present use at the Reservoir. The purposes of direct comparison with other Utah reservoirs would be served if use accounting were consistent and uniform. More importantly, baseline use statistics would provide recreation planners and Reservoir administrators with a point of reference for future comparisons of growth and development needs at the Reservoir.

A number of estimates of recreation use have been made for Strawberry Reservoir. Table 12 depicts the estimates of opening day visitation and seasonal visits encountered during the study. Most of the available estimates are from newspaper accounts, although the U.S. Forest Service and National Park Service have also provided estimates.

For the purposes of this study, total recreational use at Strawberry Reservoir was calculated for the 1975 summer season of 113 days from 30 May to 12 September. This calculation was derived from permit sales data of the Strawberry Water User`s Association, U.S. Forest Service visitor records at the Bryants Fork Campground, and permit sales data at Trout Creek Boat Camp. From these sources, it was concluded that approximately 239,000 user visits occurred at the Reservoir during the 1975 season, and that approximately 400 user parties were present on any one day of the season. Table 13 describes total use at the Reservoir during the season. Traffic counts were used to illustrate fluctuations of use and seasonal patterns were inconclusive in determining total use due to the malfunctioning of the Forest Service counter on the main access to the westside areas.

A total of 240,000 visits represents a larger visitation rate than had previously been reported. Previous estimates seriously underestimated total visitation at the Reservoir. In fact, visitation in

1975 approximates year 1 projection for an enlarged reservoir (Royer and Dekker 1976).

TABLE 12
PRIOR ESTIMATES OF VISITOR USE

Use Period	Use Estimate	Source
Opening Day	20,000 visitors 7,700 fishing boats	Alexander (1971)
1972	10,000-11,000 visitors 3,000 fishing boats	Christiansen (1972)
1970`s	20,000 visitors	Ewer (1975)
1970`s	30,000 visitors	Deseret News (1975b)
1974	1,300 fishing boats 2,000 shore-fishing visitors	Wharton (1975b)
1975	11,000 visitors/ice	Wharton (1975a)
1975	4,000-5,000 visitors 463 fishing boats	Wharton (1975b)
Season		
1964	110,000 "angler days"	U.S. Forest Service-Natonal Park Service (1968)
1970's	100,000 visitors	Deseret News (1975b)
1980	850,000 "general recreation days"	U.S. Forest Service-National Park Service (1968)
2000	1,200,000 "general recreation days"	U.S. Forest Service-National Park Service (1968)
Year 1 - Enlarged	300,000 "general recreaton days"	U.S. Forest Service-National Park Service (1968)

Source: (Royer and Dekker 1976).

TABLE 13
TOTAL USE AT STRAWBERRY RESERVOIR, 1975 SUMMER SEASON

Recreation Use Period	Number of Parties	Number of Users
Average Day of Season	399	2,116
Total 113-Day Period	45,125	239,164

Source: (Royer and Dekker 1976).

The major number of Reservoir users came from Utah.

Despite Strawberry Reservoir's location on a major Federal Highway, U.S. 40, an overwhelming majority of Reservoir users live in the State of Utah. Strawberry Reservoir did not attract the out-of-State traveler in 1975, and only 6 percent of the visits can be attributed to nonresident recreationists. The few out-of-State visitors usually belong to multiple-origin parties headed by Utah residents. Table 14 shows the state origins of Strawberry visitors.

TABLE 14
VISITOR ORIGIN BY STATE[a]

State	Percentage of Total State Origins
California	3.4
Idaho	0.5
Nevada	0.5
New Jersey	0.5
New York	0.5
Ohio	0.5
Washington	0.5
Utah	93.7
TOTAL	100.1%

[a]In multiple-origin recreational parties, out-of-State origin represents the incidence of out-of-state subgroups within the party.

Source: (Royer and Dekker 1976).

This finding contrasts with prior objections of nonresident use of Strawberry Reservoir. In 1968, the

U.S. National Forest Service-National Park Service predicted that, "Nonresident use of the area is also expected to be substantial. The north shore of Strawberry Reservoir would abut U.S. Highway 40, a heavily traveled transcontinental highway and direct east-west route between Denver, Colorado (440 miles), and Salt Lake City, Utah (75 miles). Travel on U.S. Highway 40 should greatly increase in the future with the completion of the Loveland Tunnel through the Rocky Mountains west of Denver. This tunnel on U.S. 6 and I-70 will eliminate the 11,922-foot pass. It will permit travel west from Denver to traverse I-70 for 75 miles, then return to U.S. 40 over the present high speed route with a slightly reduced mileage. The proximate location of U.S. Highway 40 to Strawberry Reservoir and the highway's out-of-State routings did not influence nonresident use in 1975.

There are several possible explanations for the lack of nonresident tourism at the Reservoir. Most tourists are not attracted to recreational destinations that are strongly oriented to water sports activities. For example, a study of nonresident visitation to the State Park System indicates that nonresidents prefer the "historical" and "natural" units to the "boating" units in the system. An analysis of the activity participation patterns of tourists at the State boating parks indicates that water-oriented activities are of minor significance. For example, noresident participation in the waterskiing, boating, sailing, swimming, and fishing activities was respectively 3.3, 11.8, .3, 27.3, and 27.3 percent of each total activity participation rate. Because nonresidents are not attracted to water-oriented sites, the possibility that other U.S. Highway 40 reservoirs such as Starvation, Bottle Hollow, and Steinaker have intervened and intercepted potential Strawberry Reservoir tourists, seems remote...

The overwhelmingly Utah resident use of the Reservoir exhibits a distinctive pattern of in-State visitor origins. Over 80 percent of these Utah residents are from Utah and Salt Lake counties, while Davis, Tooele, Wasatch, and Weber counties contribute only 14 percent of the remaining visitors.

The large population of Salt Lake County obviously influences the visitor origin by county relationships. To eliminate the influence of population, the top ranking counties or those counties individually exhibiting over 2 percent of the use at Strawberry were ranked according to the per-county's residents to visit the Reservoir. Although Salt Lake County contributes almost 1/2 of the visitors because of its large population, the average Salt Lake County resident does not

exhibit as strong an affiliation with the Reservoir as do residents of Tooele and Utah Counties. In this sense, Tooele County is the most important county of visitor origin.

Mode of Participation. Strawberry Reservoir is primarily a single destination for its users. Significantly, only 1 percent of the interviewed parties were visiting the Reservoir as part of a larger trip. Table 15 depicts this relationship.

TABLE 15
PARTY TYPE BY MULTIPLE OR SINGLE DESTINATION

Party Type	Number of Parties	Percentage of Total Parties
Strawberry Reservoir Destination	44,629	98.9
Multiple Destination	496	1.1
TOTAL	45,125	100.0%

Source: (Royer and Dekker 1976).

Seventy-five percent of the recreationists stay overnight at or near the Reservoir (Table 16), while the remaining 25 percent visit the Reservoir on a day use basis. The actual number of hours spent at the Reservoir by day users could not be determined from on-site interviews. Length of stay does not seem to be strongly linked to fishing success.

TABLE 16
DAY-USE AND OVERNIGHT PARTIES

Length of Stay	Number of Parties	Number of Individuals	Percentage of Total Parties
Day-Use	11,326	60,030	25.1
Overnight	33,799	179,134	74.9
TOTAL	45,125	239,164	100.0%

Source: (Royer and Dekker 1976).

The length of stay of overnight parties ranges from one to seven nights. One- to three-overnight trips pre-

dominate, with the average overnight trip a 2.2-night experience. Table 17 summarizes the length of stay of overnight parties.

TABLE 17
LENGTH OF STAY BY NUMBER OF NIGHTS
OF OVERNIGHT PARTIES

Number of Nights	Number of Parties	Number of Users	Percentage Total Overnight Parties
1	16,516	87,534	36.6
2	13,131	69,597	29.1
3	11,101	58,834	24.6
4	2,346	12,437	5.2
5	993	5,262	2.2
6	361	1,913	0.8
7	677	3,587	1.5
TOTAL	45,125	239,164	100.0%

Average number of overnights 2.2 nights

Source: (Royer and Dekker 1976).

Although the data indicate that relatively few recreationists are presently staying at the Reservoir for more than 2 or 3 days, it should be noted that a majority of Strawberry users make short trips on a regular basis during the fishing season. Those parties with cabin or trailer leases in the four fishing camps represent a different type of user and were lightly sampled in proportion to their actual numbers. These parties may be better equipped to spend long periods of time at the Reservoir. As indicated in Table 18, approximately 97 percent of the overnight visitors stay on the Reservoir shoreline. The remaining 3 percent utilize summer homes or motels in the vicinity or stay at the Forest Service's Lodgepole Campground west of the Reservoir on Highway 40.

TABLE 18
LOCATION OF OVERNIGHT STAY

Location	Number of Parties	Number of Individuals	Percentage of Total Parties
Reservoir Shoreline	43,862	232,467	97.2
Bryants Fork Summer Home Area	496	2,631	1.1
External Location	767	4.066	1.7
TOTAL	45,125	239,164	100.0%

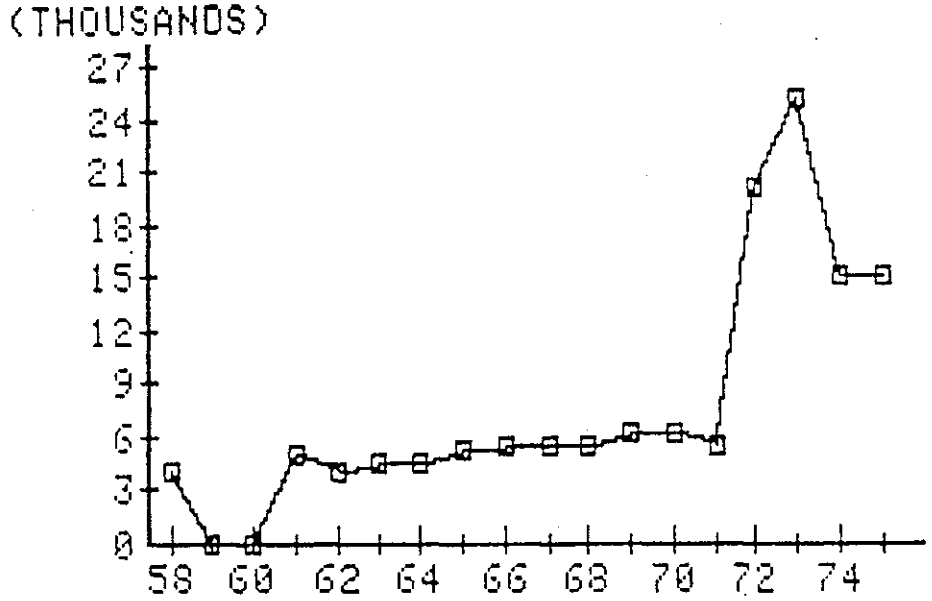
Source: (Royer and Dekker 1976.)

> The overnight accommodations on the Strawberry Reservoir shoreline exhibit an almost bewildering array of vehicular and semipermanent accommodations. Pickup campers are the most popular overnight accommodation...
>
> Recreation visits to Strawberry Reservoir are characterized by party visits rather than individual visits. Visits are also characterized by parties of large size, with over 45 percent of the users in parties of five or more members. The multiple-family party is particularly evident, and almost 47 percent of the user groups included more than one family. Many parties include three or four generations of Utahns. There is a high proportion of party heads who are 50 years of age or older. Almost one-half of the parties contain three or more adults (Royer and Dekker 1976).

There are three major types of recreation carried on in and around the Strawberry Reservoir: hunting, fishing, and sightseeing. It is difficult to place a value on any recreation activity. One method, however, that is widely used is to examine the additional money that sportsmen are willing to spend to engage in that activity. The amount spent to participate, measures a "willingness" to pay for the right to be involved in that activity. Demand has often been defined as the "willingness and ability" to pay for a commodity. These expenditures, however, measure only a lower bound on the "willingness to pay." Many sportsmen would be "willing to pay" more than the price they now do for the Strawberry Project recreation. The value of this recreation is therefore higher for a substantial part of the group, a value not reflected in the gross measure of "willingness to pay."

Hunting activity has increased in the area surrounding the Strawberry Reservoir as shown in Graph 20. At 15,000 visitor days for hunting purposes, gross expenditures associated with the hunting activity would exceed $600,000 in 1980 prices if all the hunters were residents of Utah (Mercier 1982).

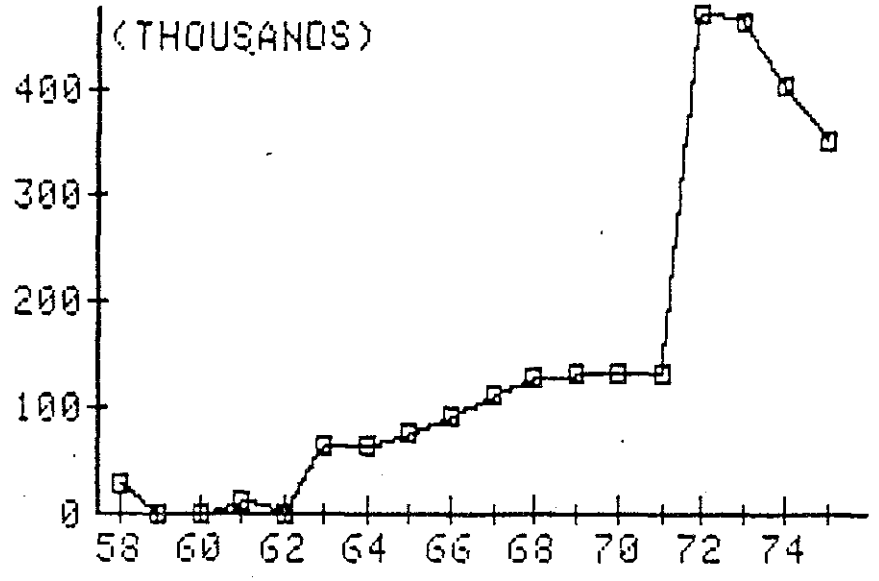
GRAPH 20
TRIPS TO STRAWBERRY FOR HUNTING PURPOSES



Source: (Mercier 1982).

Fishing activity, which has averaged better than 200,000 visitor days since 1971 (Graph 21), might induce an annual gross expenditure of from $2,000,000 to $10,000,000, based on estimates of an average expenditure per visitor per day (Royer and Dekker 1976; Mercier 1982).

GRAPH 21
VISITOR DAYS TO STRAWBERRY FOR FISHING PURPOSES

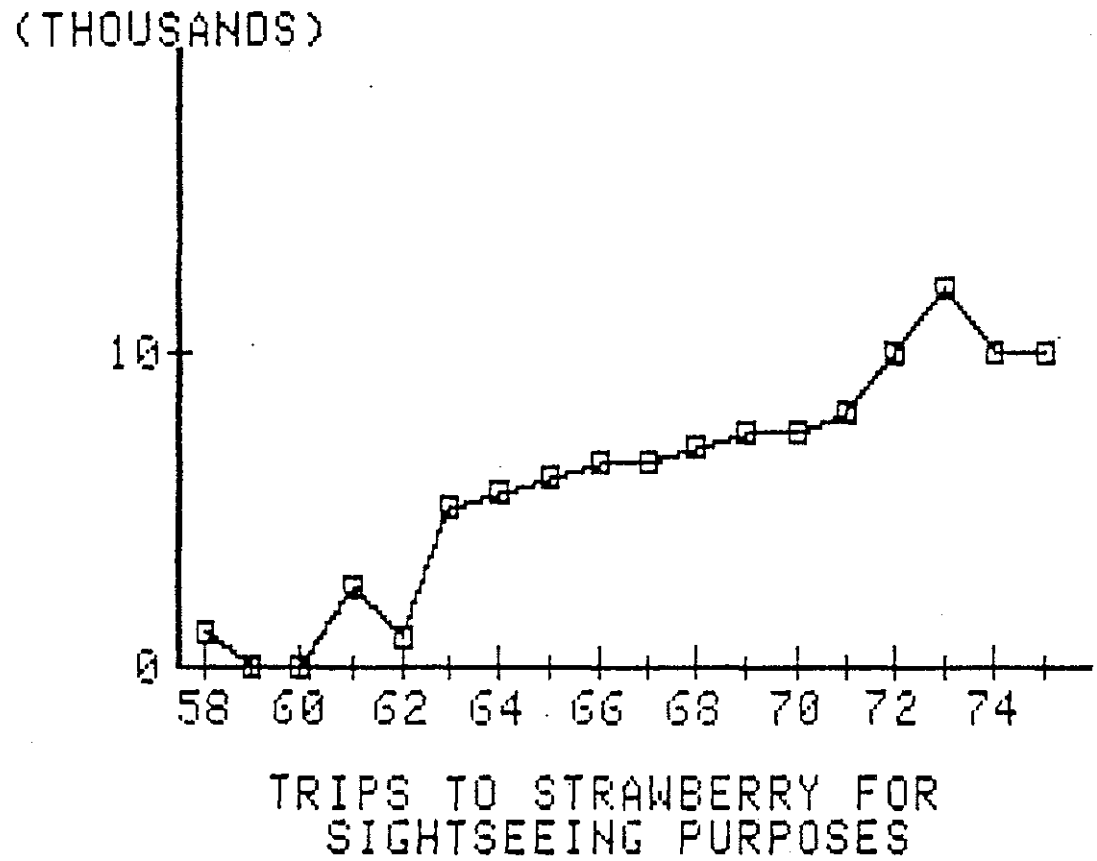


Source: (Royer and Dekker 1976).

Since 1971, expenditures at the Reservoir have been nearly $2 million a year (Royer and Dekker 1976). It can be argued that the existence of the Project stimulates at least $2 million in economic activity. It might be fallacious, however, to suggest that the value of fishing recreation from the Strawberry Project reaches $10 million per year. Once again, these are not marginal expenditures.

Even the number of visitor days for sightseeing has increased steadily since 1958. (See Graph 22.)

GRAPH 22
TRIPS TO STRAWBERRY FOR SIGHTSEEING PURPOSES



Source: (Royer and Dekker 1976).

Since the Association first rented 1800 acres to the Goshen Gun Club in 1914, earnings from recreation on the Strawberry Reservoir have made a significant contribution to the financial solvency of the Association. Revenues from recreation fees have consistently exceeded recreation maintenance costs. (See Table 19.)

TABLE 19
RECREATION RETURNS AND COSTS

Year	Return	Cost
1970	37,082	25,701
--	--	-- *
--	--	--
1973	102,357	46,090
1974	96,127	42,567
1975	103,661	62,504
1976	104,071	99,861
1977	106,601	61,609
1978	141,218	77,484
1979	149,201	82,556
1980	129,690	90,310

*Missing Data

Source: (Strawberry Water Users Association 1970, 1973, 1979, 1981).

Recreational use of the Reservoir has also caused some significant problems.

> During the 1975 recreation season at Strawberry Reservoir, administration and management of the recreational resource were plagued by an unusual set of problems...
>
> Heavy snowfall and the late thaw created an unusually heavy runoff, with the Reservoir filled to capacity by late June. This was the highest pool since 1952. The unfortunate effect of storage was to flood many of the trailers and cabins on shoreline leases in the fishing camps; rows of outhouses were also flooded. The situation precipitated a warning by the Utah Division of Health that it would be "absolutely necessary" to relocate all cabins and trailers to at east 100 feet beyond the shoreline to prevent water contamination. The Strawberry Water Users` Association emphasized that it would be impossible to move the structures until the water receded. The Association also maintained that even if removal were possible, lease sites were unavailable for relocating the dwellings. Thus, practical solutions to the problems of sanitation and damaged dwellings were not found.
>
> The high water level severely restricted fishing and camping access...Faced with wet and muddy road

routes and vehicle trails to favored shoreline destinations.

The high water conditions of 1975 served to highlight sanitation problems that have been evident in the Strawberry fishing camps for the past 10 years. A water quality study conducted during the summer by Brigham Young University's Department of Civil Engineering showed extensive contamination of the Reservoir. The report described sanitation practices at Strawberry as "intolerable."

In October, the Utah Division of Health announced plans to eliminate health code violations at the Strawberry fishing camps. These violations were depicted as the "largest concentration of unapproved, illegal and improperly installed wastewater systems in the State." Consequently, on 4 November, all public and private facilities on the Reservoir were ordered closed by the Utah Division of Health. If the camps were to reopen for the 1976 season, the Strawberry Users' Association and camp operators would have to submit acceptable compliance schedules for meeting the State health and sanitation regulations. The State Director of Health pledged to bring legal action against any Strawberry owner or operator who did not initiate cleanup work within 30 days.

The management problems and dilemmas of the Water Users' Association were not limited to health code violations in 1975. The Associations' fee collection system was also criticized by Wasatch County officials. The complexity of public access to the Reservoir has raised legal questions regarding the manner in which the Association administers entrance fees (Royer and Dekker 1976).

Although the future of Association managed recreation is clouded, it is obvious that the Project has generated significant recreation benefits, and those benefits have helped pay back the cost of construction.

As part of the Central Utah Project, the Strawberry Reservoir is currently being enlarged. The higher water level will flood shoreline areas now occupied by Strawberry Water Users Association cabins and recreational facilities. In 1976, the Bureau of Reclamation in conjunction with various other State and Federal agencies prepared a recreation master plan for the enlarged reservoir.

The plan calls for removing the existing cabins and sanitary facilities as the reservoir expands and replacing them with various overnight campgrounds, day-use picnic areas, and boat ramps and other types of access which will take full advantage of the Strawberry Reservoir's prime fishing potential. All of the

new facilities have been designed to make as little impact on the environment as possible. Most are topographically screened from the highway, and all of them have been set back from the shoreline. New utilities, including a sewage system, will be installed that meet all applicable state and local codes. The Bureau of Reclamation will have administrative responsibility for the new recreation facilities.

XII. STRAWBERRY VALLEY PROJECT--SECONDARY ECONOMIC IMPACTS

From the very beginning, Mormon leaders recognized that the development of water had "secondary economic impacts." Although they would not have used that term, without water development for agriculture, their intention to create a stable, long-term society in the isolated Intermountain West would have been impossible. Not only did it serve as one of the major supports of the local economy, but served as the basis for the development of specialized services in nearby towns. During the first half-century of economic development in Utah, the State's irrigated agriculture not only served the needs of her farmers, but mining and railroad communities throughout the Great Basin, as well. The development of water for irrigating Utah's farms clearly had a secondary, regional impact. John Luckett in his testimony before the Senate Select Committee on Irrigation and Reclamation of Arid Land voiced this perception:

> Irrigation has prevailed in Utah for nearly 40 years. Not one-fifth of the present population could be sustained without it upon the soil of the Territory. As it is, Utah feeds not only its own populaton of at least 175,000 persons, but has a considerable surplus for sale to others...Elsewhere, there are smaller communities, but at least 125,000 persons are located within the east and west portions of the dozen counties into which this central belt of Utah is subdivided.
>
> These communities are favorably located to command all local trade and communication as well as the several sources of water; but the main concentration referred to is a sticking characteristic of the sagacious economic manipulations which mark the settlement and development of the major portion of Utah--of all of it, in fact, outside the chief railroad towns and a few mining districts. It is these things which have given, as one of their special features, such an interesting development to irrigation under them... (Luckett 1890).

At an early date, Utahns realized that water was necessary for a sustained economic development in the area. As Utah's economy became more complex in the 20th century and was increasingly integrated into a regional economy, the regional secondary impacts of water development have become more important. The analysis of those impacts has also become more sophisticated. If the development of a resource, such as water, is to cause an increase in regional economic activity, a sequence of phases has to occur.

(1) Resource development (i.e., the creation of regional economic activity potential).

(2) Changes in the relative productivity of land, labor, capital in the Project region as compared to other regions.

(3) A broadening of the range of producer and consumer choice.

(4) Intra- and interregional movement of capital and labor.

(5) Direct and indirect forward and backward linkages with other sectors of the economy.

(6) Indirect impacts associated with agglomeration and scale economies and the attainment of minimum threshold levels for development of certain specialized activities, i.e., wholesaling professional services, etc. (Lewis, et al. 1973:81).

The Strawberry Project seems to have accomplished these phases to a major degree.

RESOURCE DEVELOPMENT

The introduction of additional water increased the effective supply of productive land by providing both supplemental water for partially irrigated land and water for new land. Even though all Project lands were privately owned and farmed before the Project, most of the lands were previously just partially irrigated or were dry-farmed. One third of the 67,000 irrigable acres within the Spanish Fork, High Line, and Springville/ Mapleton districts, were fully irrigated by Project water, with an additional 27,000 acres receiving a supplemental supply. High Line District lands were not irrigated at all prior to the Strawberry Project. In addition, water for municipal use was augmented, electric power provided, recreation increased, and other products created. Approximately 5,000 to 6,000 acre-feet have been delivered annually to municipalities for irrigation purposes since early 1950 (Strawberry Valley Project Annual History 1927-1965:16-22). Power generation from the Project has averaged 10,000,000 kwh since the early 1940`s. There have been in excess of 200,000 recreation visitor days annually since the early 1960`s. There is little doubt, but that the Project has created regional economic activity.

CHANGES IN RELATIVE PRODUCTIVITY

In the early 20th century, there was a great push by State and Federal Governments to create new productive capability in agriculture. This was facilitated, to a great degree, by the development of water projects in the West, like Strawberry Valley. These developments increased the capacity of land, labor, and capital in the west. Clearly, the irrigated Project land became more productive relative to nonproject lands. Lewis, et al. (1973:85) have shown that, in general, water development investments work toward increasing wages in the project area.

There is little doubt that the Strawberry Valley Project resulted in higher local wages and higher employment than would have existed without the Project and did produce an increase in total wage income.

A BROADER RANGE OF PRODUCER AND CONSUMER CHOICE

Higher incomes imply an increase in the effective range of economic choice for area residents. The impact of an improved water supply on the agricultural sector is increased farm productivity and income, assuming that increased output has not depressed commodity prices. Given the small proportion of production relative to the rest of the region, this seems an appropriate assumption. An adequate and reliable water supply increased producer choices in that it allowed project farmers to raise a larger variety of crops and improved their ability to adapt to changes in the market. It is significant too, that during this period in U.S. history, increased agricultural productivity allowed for the movement of agricultural workers to manufacturing and other pursuits because basic food needs could be met with a smaller labor force. In addition to an expanded agricultural commodity selection, consumer choices were expanded as a direct result of other project features, such as power and recreation.

INTRA AND INTERREGIONAL MOVEMENT OF CAPITAL AND LABOR

Increased employment resulted from the Project. Most of the workers in the tunnel, on the dams, dikes, powerhouse, and canals came from Utah and Wasatch counties into the project area. Construction employment averaged more than 20 Federal employees and in excess of 100 contractual employees (Strawberry Valley Project Annual Histories 1906-1920). Some interregional labor movement, mostly in the form of Bureau and Construction Administrative personnel, is also recorded. Other interreginal movements of labor no doubt occurred. Movement of financial capital by the Federal government provided an important source of cash income during the construction phase and provided a great boost to buying power. Interregional shipments of physical capital were particularly noteworthy. Since Utah did not have a strong industrial base, many of the "manufactured" items used in the construction process were imported into the region for project purposes and for project construction and subsequent operation and maintenance. During all phases, new services and increased production have kept employment higher than it would have been without the project.

DIRECT AND INDIRECT FORWARD AND BACKWARD LINKAGES

The increase in population and basic economic activity generated multiple income effects on the production, retail, wholesale, and service sectors of the economy in both local and neighboring regions. Backward linkages have been important in that these effects (known as "induced by") have created a demand for agricultural service industries to supply all of the farmer's

production needs from tractors and machinery to seeds and fertilizer. As farmers tended to emphasize production, other industries were formed to provide the other necessary inputs. Forward linkages have developed to process and market produce (called "stemming from"). These activities have become far more important with passage of time. As agriculture has become more complex and mechanized, and as consumers have demanded more highly processed food, the backward and forward linkages have increased greatly; however, as mobility has increased, the services have been spread over a much broader geographic area. So, for a specific local area, linkage impacts have been offset--at first, smaller linkages occurred, but more localized; then, greater, but more widely dispersed linkages occurred. Economists have estimated multipliers or estimates of the net linkage impacts of many kinds and sizes for both agricultural and other sectors of the economy.

ECONOMIES OF SCALE

The impact of backward and forward linkages on local economies depends to a great extent on "leakages," on payments made for goods and service outside the region. A leakage is considered to occur any time that a product is imported and no compensating goods are exported from the region. In other words, there is a net overflow of "value" in goods and services. Wholesaling and business services, as compared to retailing, are found only in at least modestly urbanized settings. If the Project area is reasonably well developed, leakages will be minimized because most of the goods and services are produced locally. The state of development in Utah has changed much in the past 70 years. An expanding scale of population and economic activity has kept the leakages down as the forward and backward linkages have developed. Agglomeration, or grouping together, has occurred and scale economies have been realized as activity has increased. At present, economic activity within the State has developed to the point that few leakages exist. In other words, as population and economic centers grew, new products and services could now be provided on a local basis in Utah. The presence of large scale enterprises associated with the Project like canneries and sugar beet factories made possible the local production of a wider range of goods and services.

THE ROLE OF WATER DEVELOPMENT

Many economists tend to diminish the role of water development in regional growth. A general consensus seems to have developed around the idea that water availability is a <u>necessary</u> but not sufficient condition for economic growth. Howe states that "...water resource developments are likely to be poor tools for accelerating regional growth..." (Howe 1968). In another study, the growth implications of large multiple-purpose water projects in 61 counties were examined for the 1948-58 period.

> ...We concluded it is dubious whether water resource projects serve as a stimulus to economic growth for strictly rural counties in the Northeastern United States. We must seriously consider the possibility, as Howe did in his study of larger regions, that water resource developments are likely to be poor tools for accelerating economic growth of small rural regions of the Northeastern United States...(Cox, et al. 1971).

There was a problem with the statistical technique Cox used to measure the impacts of water development. It is quite probable that some explanatory variables were wrongly credited with the economic development effect (Lewis, et al. 1973). Others have shown positive effects, such as a one percent increase in water availability increases employment in various industries by some "X" percentage. Unfortunately, agriculture was not estimated (Ben-David 1970). What Howe and others have really examined is the relationship between water availability and growth, not investment and growth. It is likely that water availability did influence Utah County growth, and that investment impacts from the Strawberry Valley Project had been largely exhausted by 1950 (Lewis, et al. 1973).

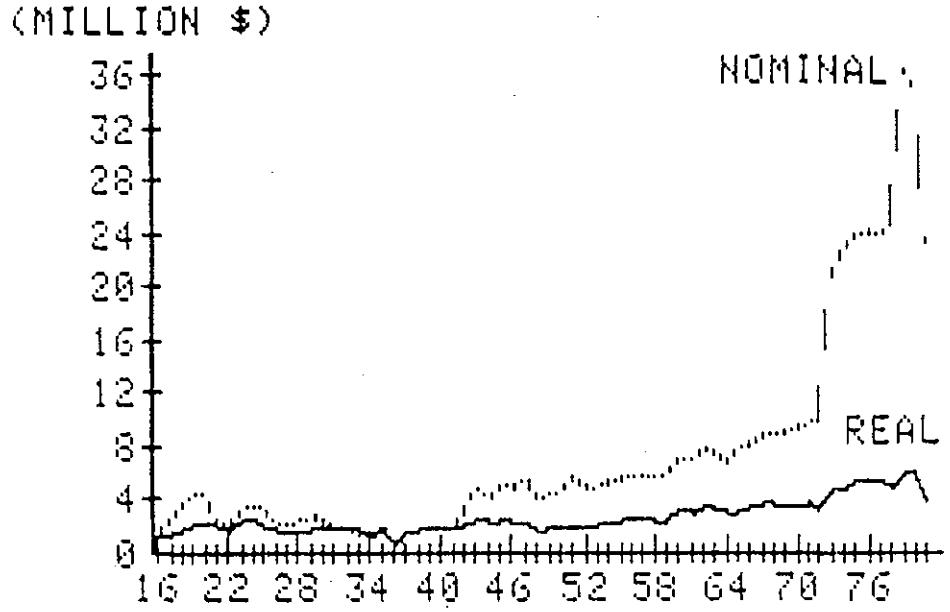
These recent studies also do not really address the question of starting from an underdeveloped situation and building to a stable economy. The fruit and vegetable processing plants that developed in the area would not have existed without Project water. It is doubtful that an expansion of the existing sugar refineries would have occurred either. Many stores and businesses in town that supplied agricultural machinery, fertilizer, feed and other supplies expanded and new businesses were created. Needs for increased sales of consumer goods for a population basically supported by agriculture would not have existed without the water development. The livestock industry is also dependent on feed produced under the Project. Services have grown (medical, legal, etc.) because of the sustained population. Government employment increased significantly to serve the needs of the public in schools, roads, and other public activities.

Though estimates of employment and income multipliers do vary, a number of sources (Andersen, et al. 1962; Andersen and Wilkes 1968; Bradley 1967; Godfrey 1965; Lanphear and Roesler 1974; Schink and Fitz 1980; Torrico-Soria 1973) indicate that an appropriate estimate for basic income, employment, and production multipliers is about 2.0, at least for agriculture. That means that for each additional unit of employment in agriculture due to increased activity on the Project, one more unit of employment will be created in other sectors as the successive rounds of economic activity are generated. The same general relationship holds for income generated, and for output of products measured in value of production. This relationship goes on in perpetuity. The annual real gross income resulting from the increased agricultural production has averaged an estimated $1.2 million over the life of the Project. Graph 23 shows an estimate of the total annual gross economic impact, including the value of agricultural

production, in both real and nominal terms (Strawberry Valley Project Annual Histories 1906-1975; U.S. Bureau of Reclamation 1975-1981; Strawberry Water Users Association Annual Crop and Livestock Reports 1926-1950).

The multiplier discussed above implies that the annual gross economic impact of the Project has exceeded $2 million annually (in real terms) since the completion of the Project. These gross impact values do not necessarily justify the Project, however, since the justification for such a project should be based on the added or "marginal" contribution it will make. It's real value is more a function of net returns after the cost of production has been subtracted from the gross value. While the above studies and many others give more precise values of multipliers for particular locations, the Strawberry Project began long ago and has faced so wide a range of general regional economic conditions since that time that it is difficult to calculate a multiplier, specifically for the Strawberry Project. No closer estimate seems feasible. The estimated impact of $2 million a year in the local economy is a very significant impact.

GRAPH 23
ESTIMATED TOTAL ECONOMIC IMPACT OF STRAWBERRRY VALLEY PROJECT



Source: (Strawberry Water Users Association 1916-1982; Strawberry Valley Project Annual Histories 1916-1982).

One of the fundamental questions in studying the role of water development is the concern that "...regional development is multidimensional with water resources playing only one part...Thus, if regional economic development is a primary objective, water resource investment probably should be made in combination with other types of public investment..." (Lewis, et al. 1973:166). This kind of associated investment occurred in the Strawberry Project. Some of the associated investment was not planned to make a complete functional economic system, but to merely finish the Project, as with the construction of the original powerhouse and transmission lines.

One of the methods used to calculate the growth impacts due to the development of an irrigation project is to compare the project area with nonproject areas over time. The Bureau of Reclamation has used this procedure to compare the growth impacts of Strawberry Valley Project to neighboring Sanpete and Juab counties. Some caution needs to be used, however. Sanpete and Juab counties, have somewhat different economies. It seems that much of the development in Utah County is due to industrialization (which may to an extent be due to water availability, though not water directly associated with the Strawberry Valley Project) and the proximity of urban centers like Provo and Salt Lake.

For instance, the Geneva Mill of U.S. Steel has, until recently, employed on a fairly continuous basis 6,000 people. Furthermore, Brigham Young University, located in Provo, employs an additional 5,000 workers and has a fall-winter enrollment of 25,000 students. Even though these various businesses matured later in the history of the Project, they serve to emphasize that interregional growth comparisons are not without signi ficant problems. While some agricultural processing industries located in the region as a result of Strawberry Project water, it is not obvious that some of these other industrial and service enterprises located in the area as a direct result of water from the Strawberry Project.

E. O. Larson undertook an interregional comparison between Utah, Sanpete, and Juab Counties in an effort to quantify Project benefits. While Larson's conclusion can be substantiated by other approaches, his methodology has been questioned. Still, a comparison of two somewhat similar regions can provide a measure of the relative contribution of a project such as the Strawberry Valley Water Project.

> As a comparison study, we have selected two areas adjacent to the Strawberry Valley Project similar in soil, climate, rainfall, and also the type of people who originally settled the areas. These areas are Juab and Sanpete Counties. The one great difference between these areas and the Strawberry Valley Project is their lack of an adequate water supply to give full utilization of the agricultural potential.

It can be observed from Figure 94 that the population

> growth in all three areas advanced to about 1910 at somewhat the same rate. These areas were all settled at a rather rapid rate because of the influence of the Mormon Church in moving converts from Europe and elsewhere to the various regions surrounding Salt Lake City. By about 1910, the full potential of the water supply from the natural streamflows had been reached. In 1915, the Strawberry area received its first storage water from the Project, and the population and other types of growth continued upward. In the other two areas, their growth was controlled by the amount of water available showing that the maximum point was reached about 1910-15, and from that time until now the population has shown a stagnation and decrease. This situation has a depressing effect on all real estate values as well as the human attitude toward the community (Larson 1955:26).

Taking into account the industrial growth of the county as well as Project development, Larson has estimated the population growth due to the Strawberry Project, as shown in Figure 94.

Personal income has also been estimated as follows:

> Personal income in the area has increased throughout the years and is quite comparable to income in the State as a whole, which in 1954 averaged $1,483. The Project area on the basis of population and average income would have a total personal income of about $18,000,000 being attributed to the Project (Larson 1955:31).

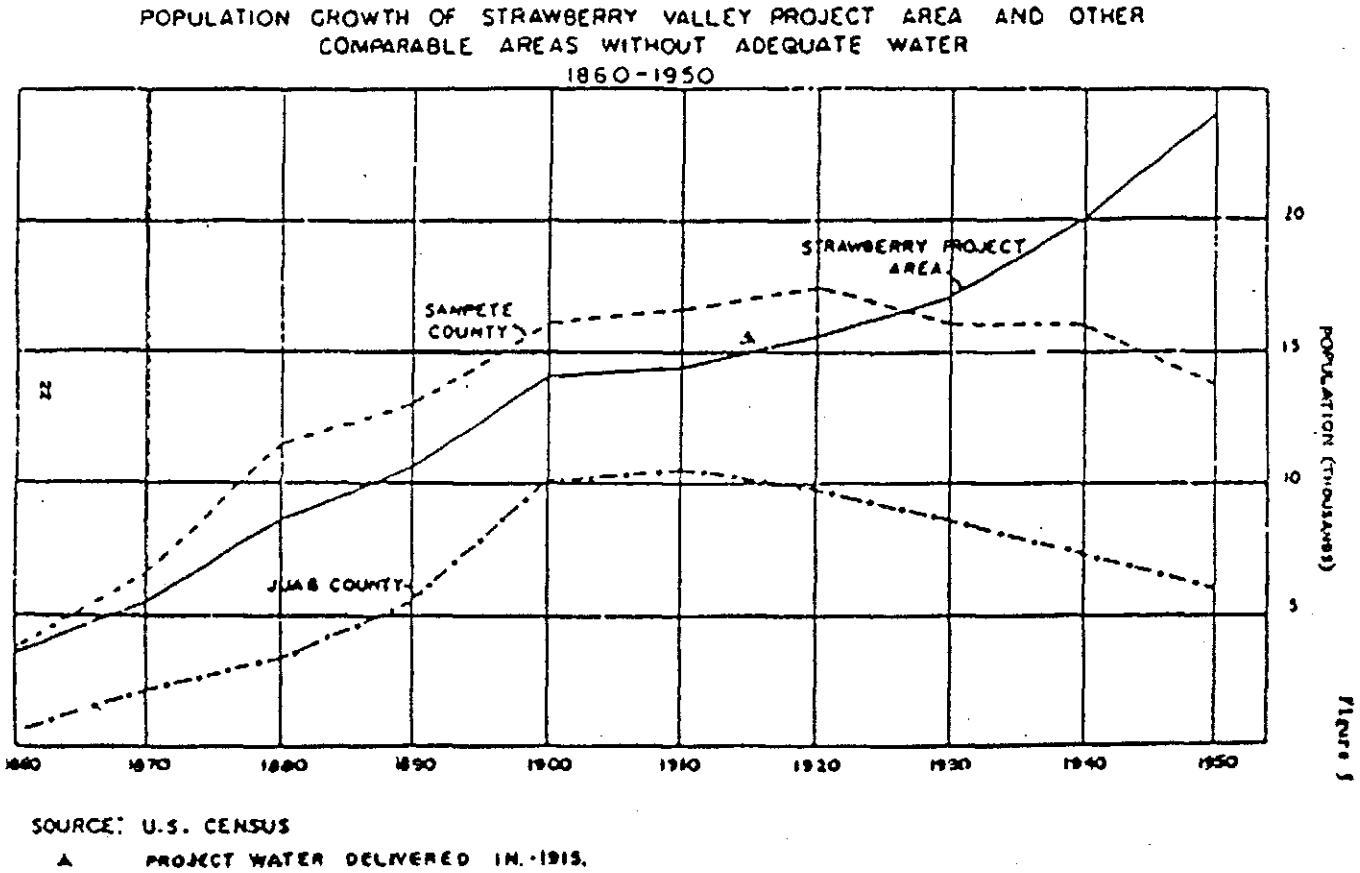


FIGURE 94. STRAWBERRY VALLEY PROJECT POPULATION ESTIMATED.

Source: (Larson 1955:26).

It is important to note that the Strawberry Project, like others, is not just of regional benefit. The flow of goods into the area (as well as those shipped out) generates business all over the country. Table 20 gives car and truck purchases in the Project area. No doubt many of these vehicles would not have been purchased if the Project had not been built.

TABLE 20
NUMBER OF NEW CARS AND TRUCKS
SOLD ANNUALLY IN PROJECT AREA

	Springville		Spanish Fork		Payson		Salem		Santaquin		Goshen		Elberta		Project Total	
	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks
1950	326	107	352	125	140	30	26	30	40	8	26	6	2	5	912	311
1951	215	97	289	78	118	23	20	23	21	12	13	19	3	1	679	253
1952	185	63	225	77	96	30	14	30	27	5	15	9	4	0	566	214
1953	182	60	273	73	112	13	17	13	25	10	12	8	3	1	624	178
1954	152	56	235	52	77	21	9	21	20	4	12	13	2	2	507	169
TOTAL	1060	383	1374	405	543	117	86	117	133	39	78	55	14	9	3288	1125
Yr Ave	212	77	275	81	109	23	17	23	26	8	16	11	3	2	658	225

Source: Utah Auto Dealers' Registration Service Company - Report on Sales Registration (Larson 1955:34).

Tractor implements, farm supplies, and consumer goods are important sources of local, regional, and national economic activity. Table 21 gives estimates of these Project purchases.

TABLE 21
THE PROJECT AS A MARKET FOR OUT-OF-STATE PRODUCTS

Item or Type of Retail Store	Avg. No. Sold Last 5 Years	Annual Volume of Sales	Est. Amount Leaving State[a]
New Cars	658	$ 1,842,000	$1,474,000
New Trucks	225	495,000	396,000
Farm Tractors (New)	156	263,860	211,000
Farm Implements (New)		235,500	188,000
Fertilizers		54,000	38,000
Building Material		2,426,000[b]	1,334,000
Home Furnishings		1,146,000[b]	688,000
Clothing		647,000[b]	388,000
General Merchandise		2,016,000[b]	1,210,000
Foods		4,741,000[b]	1,896,000
Drugs		609,000[b]	396,000
Eating & Drinking Places		1,082,000[b]	417,000
Gasoline, Oil & Parts		2,275,000[b]	1,138,000
TOTAL		$17,832,360	$9,774,000

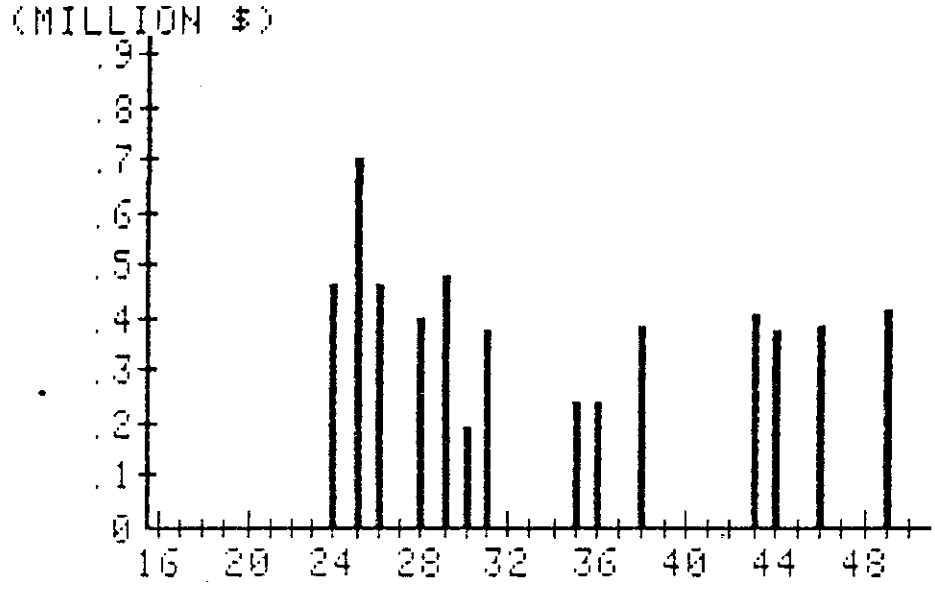
[a]Estimates based on reports from local retail store operators of percentage to total volume.

[b]Based on per capita sales in Utah County from "Consumer Markets - 1955" Published by Standard Rate & Data Service, Inc. Population of Project area estimated at 26,000 for 1954.

Source: (Larson 1955:36).

The value of equipment and machinery associated with production on the Strawberry Project for select years is shown in Graph 24. (Strawberry Water Users Association Annual Crop and Livestock Report 1916-1950).

GRAPH 24
VALUE OF MACHINERY AND EQUIPMENT STRAWBERRY WATER PROJECT
(1916-1950)



Source: (Larson 1955).

The value of land, and buildings, and machines was estimated at $10,192,305 for 1924, when there were 36 tractors being operated on Project farms. In 1926, a complete machinery inventory was taken. The results are given in Table 22.

TABLE 22
EQUIPMENT INVENTORY (1926)

Item	Number	Value/Unit
Binders	275	$ 100
Threshers	22	2,500
Tractors	51	400
Manure Spreader	150	100
Hay Balers	4	200
Headers	4	350
Wagons	1,000	
Mowers	500	60
Plows	550	60
Rakes	500	30
Loaders	13	100
Corn Cutters	6	150
Bull Rakes	3	90

Source: (Strawberry Water Users Association Annual Crop and Livestock Report 1926).

Fifteen tractors had been purchased in this two-year interval between 1924-26. By 1929, 1850 automobiles and trucks valued at $500 each were owned and operated by Project farmers; however, by 1931, the number of tractors owned by Project farmers dropped to 40. The number of threshers had been reduced to 14, and the combined automobile/truck owerships declined to the 1910 figure, a precipitous drop from the 1929 figure. There was little change in these figures until the 1940`s when some expansion occurred once again.

The Bureau of Reclamation further estimated the amount of sales due to the Project.

> The publication Consumer Markets for 1955 gives a breakdown of the per capita sales by countries for 1954 by major retail store class. From this breakdown and from primary data obtained on the Project, (Figure 95) was made up. This tabulation shows that for 1954 the volume of sales in the Project area was nearly $18,000,000, of which an estimated $10,000,000 left the State. This is based on a population of 26,000 for 1954 (Larson 1955:37).

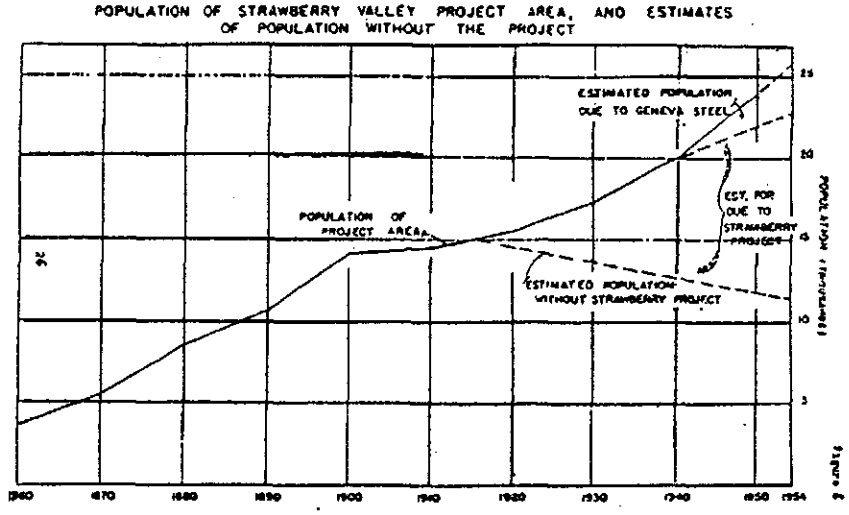


FIGURE 95. POPULATION GROWTH STRAWBERRY PROJECT AREA.

Source: (Larson 1955:26).

Amount Attributed to Strawberry Valley Project

From (Figure 95) showing the population of the Project area, it is estimated that in 1954 there were 12,000 people here as a result of the Project. The volume sales involved in interstate shipment attributable to the Project amounts to $8,232,000, of which $4,512,000 leaves the State each year. This is over 1 million dollars more in products purchased each year from the Eastern Midwestern States than the original cost of the Project (Larson 1955:37).

Taxes are another important Project benefit. An increased tax base has had great influence.

The assessed values of property in the Project area, and also for the comparison areas, from 1910 to date are shown in (Figure 96) and on (Table 23). Assessed value of mines has been eliminated from these figures, because of the wide fluctuation in values; and, also because irrigation has little effect upon this industry. From 1915 to 1920, the period when water was first delivered from the Strawberry Reservoir, the

$7,476,837 to $26,890,847. This is nearly a quadrupling of values in a period of 5 years. Although this was during a war period, much of this increase can be attributed to the Strawberry Valley Project.

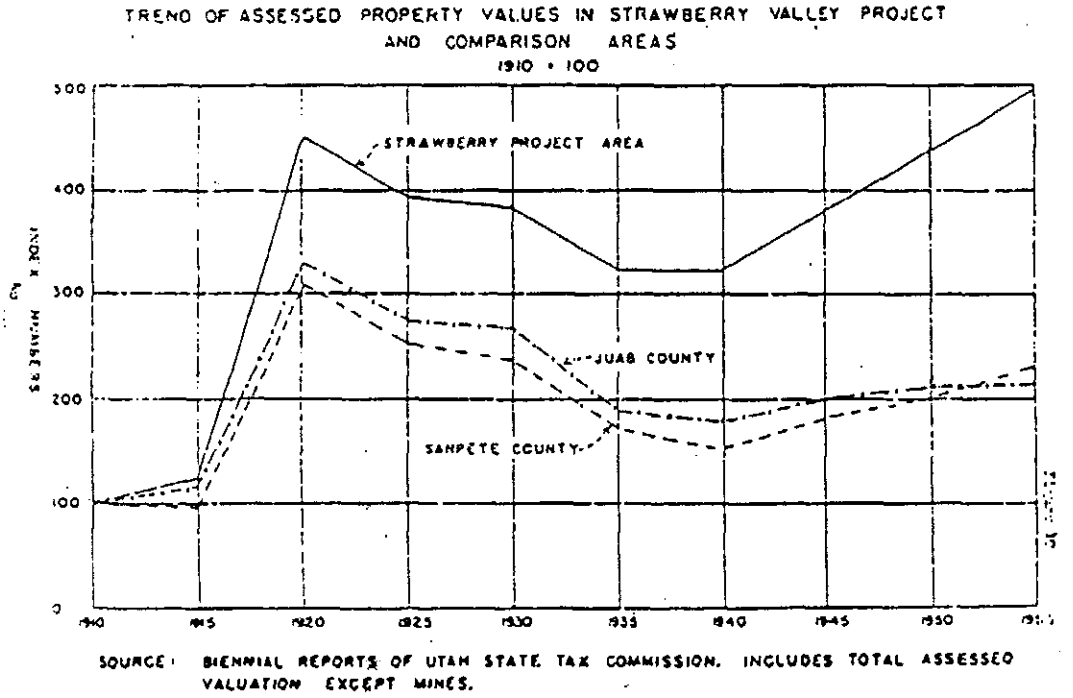


FIGURE 96. TREND OF ASSESSED PROPERTY VALUES.

Source: (Larson 1955:48).

TABLE 23
ASSESSED VALUES[a] OF PROPERTY IN STRAWBERRY VALLEY PROJECT[b] AND COMPARISON AREAS
1910-1954

Year	Project Area	Juab County	Sanpete County
1910	$ 5,934,266	$ 3,770,799	$ 5,524,063
1915	7,476,837	4,332,059	5,441,797
1920	26,890,847	12,658,721	17,286,932
1925	23,406,235	10,410,752	13,904,685
1930	22,908,982	10,150,803	13,132,035
1935	19,251,035	7,191,679	9,612,991
1940	19,288,897	6,871,909	8,552,731
1945	22,707,949	7,662,196	10,131,095
1950	26,122,345	8,102,670	11,258,627
1954	29,436,769	8,291,375	13,017,924

[a]Assessed value of mines not included because it was felt Project water has had little or no effect on assessed value of mines.

[b]These values are actually for the Nebo School District which has pratically the same boundaries as the Strawberry Project.

Source: Biennial Reports of Utah State Tax Commission (Larson 1955:41).

On the basis that the Project has created jobs and a livelihood which now supports a population of 12,000 people, we can from a per capita figure, estimate what the Project returns in taxes to the local, state, and Federal Government...In the year 1954 (for Utah), the total taxes collected from all sources amounted to $519.23 per person, of this amount State and local taxes accounted for $149.83, and the Federal $369.40. Multiplying these by 12,000 we have the Project returning $1,797,960 to the State and local governments, and $4,432,800 to the Federal Government in 1 year.

From an investment of about 3-1/3 million dollars, some 40 years ago, the Federal Treasury is now receiving nearly 4-1/2 million dollars each year in tax revenues (Larson 1955:38-39).

There is little doubt but that the Strawberry Project introduced significant secondary benefits. Population grew, retail sales increased, and support services were expanded, however, an exact quantification of secondary impacts such as was attempted to develop by Larson is not possible, given the incomplete and variable nature of the available data.

XIII. SUMMARY

During the last years of the 19th century, and early years of the 20th, Utah's legal and social institutions shaping the development of water were widely studied and discussed. Many of the men who later influenced Federal reclamation policies, spent time in Utah investigating its water development system. John Wesley Powell assigned Frederick Newell, the first director of the Reclamation Service to prepare the Utah portion the USGS's annual irrigation surveys between 1888 and 1890. Elwood Mead, third director of the Reclamation Service, served as an engineer on the Bear River Canal, and watched as Federal Homestead laws helped bankrupt the project. Mead, as head of the Department of Agriculture's Office of Irrigation Investigations, organized a major research effort in Utah between 1900-1903, to examine the State's irrigation institutions. Mead felt a particular affinity for the early Mormon system, where water was owned and controlled by the public for the benefit of the community, and water rights were administered by the government, instead of the courts. He often stated publicly that irrigated agriculture required a wholly different economic approach, because of its larger initial requirements for capital, and commended the cooperative efforts of early Mormon settlers.

Although Utah later returned control of water resources to the public, Mead, Newell, and other irrigation activists lamented the change to private ownership of water in Utah. Their views were important in shaping the bill that Francis Newlands submitted to Congress in 1901, and in the extensive debates which subsequently resulted in its passage as the National Reclamation Act in 1902. In Federal reclamation projects since that time, the water right has been tied to the land. Its continuance is based on the principal of beneficial use. And despite the fact that farmers in Utah under Federal reclamation projects must repay the construction cost in cash (instead of donating their labor as in early irrigation projects), water users associations still do not charge for water and distribute cash dividends to their members. Once a project has been paid for, the only charge is for operation and maintenance of the system.

As a smaller reclamation project, the Strawberry Valley Project has not acheived the fame of later, massive efforts on the Colorado and Columbia Rivers. But it did have some influence on Bureau of Reclamation policies on a national level, and does reflect the development of the Bureau as a whole. The early introduction of hydroelectric power as a component of Bureau projects is an obvious example. Although the Project powerhouse began producing electricity after a similar one on the Boise Project (and so is not a "first"), the Bureau realized as a direct result of the Strawberry Valley Project, that hydroelectricity could be a "paying partner" in reclamation projects. The Project also reflects the lack of economic and financial sophistication that plagued early Reclamation Service Projects.

It was many faltering projects like Strawberry Valley around the West that resulted in the Fact Finder's Commission of 1924 (chaired by Elwood Mead), and the decision to make project repayment contingent on the profits of project farmers in any given year. The fixed repayment cost went against the basic purpose of the Service to create viable new farms, by saddling farmers with a heavy, fixed cost which would have bankrupted many projects.

The Reclamation Service brought changes to Utah's water development system as well. The availability of advanced engineering and precise information on stream flows and the "duty of water" helped rationalize the development of water. Early canals and farms were located on an ad hoc basis, usually when more settlers arrived and needed more water. This small-scale development had reached its limits by the 1890's, and with it the limits of agriculture in Utah. Without the capital and technical expertise of the Federal Government, the repeated crop failures of the 1880's and 90's would have continued as the norm well into the 20th century. The Federal presence also changed the scale of water institutions as well. While many communities like Spanish Fork had five or six canal companies involved in managing the community's water resources, the Reclamation Service forced the formation of much larger water users groups. This transition was not without its hardships for those involved. Vital, and jealously guarded, existing water rights had to be merged into new and larger associations. Local water users, accustomed to complete control of their local associations and companies, now had to accept a measure of Federal control in return for the government's involvement.

With Federal involvement came an improvement in irrigation technology as well. The size of dams and canals became much larger and more efficient. Much of the Strawberry Valley Project's distribution system is concrete-lined to prevent seepage. More accurate measuring devices were installed on Project canals. The Water Users Association was also forced to develop a new system for distributing water. Farmers would place "calls" for water in the central Payson office, and a scheduler would attempt to divide the water so that the canal could be kept full, and yet have all the water used efficiently.

The Strawberry Valley Project also had a direct impact on at least one Utah law governing water--the 1917 modification of the Irrigation District Act. Reclamation Service officials lobbied for a law which would mesh with their desire to have one water users group responsible for repaying construction costs. The new law put the State's power of taxation behind water users groups who had signed a contract with the Reclamation Service. It also insured that any guarantees offered in those contracts could not be abrogated by the dissension of a minority among the water users.

The coming of the Reclamation Service to Utah in 1905, marked the end of the Church's predominate role in water development. Throughout the 19th century, the church had served as an

institutional mechanism for organizing the community's need for water development. Where the interests of the community converged, the Church was able to effectively channel those interests into public works projects. Henry Gardner was still able to "call out" the water users in 1906 to build a road in Diamond Fork Canyon to the West Portal. There is no evidence, however, that the Church was able to control the bitter disputes between the five original canals and the High Line Canal users over restructuring the repayment contract. The Mormon cooperative tradition seems to have run head on into the self interest of the older canal companies and lost, even though those under the High Line Canal were fellow members of the Church, and the community was running the risk of lawsuits and lost water.

This report has also attempted to identify events or circumstances that have some economic significance. There is little doubt that the Strawberry Irrigation Project has had a significant impact on the region. There are basically six general ways in which a project similar to the Strawberry Project can affect a region.

First, the construction of the Project introduces some positive and negative short-term economic impacts:

(1) Employment certainly increased when the Project hired local workers, particularly since under- or unemployment seems to be the norm prior to the construction phase.

(2) Wages paid to those employees were also generally higher as a result of the Project.

(3) Support services had to be provided to those employed in the Project which stimulated other business activity.

(4) At least some of the materials used in the construction process were purchased locally and tended to support local industries like Henry Gardner's Sawmill.

Negative impacts from any large construction project are primarily the social costs of the construction activity. There is usually a need for additional governmental services that must be provided by the community, often without an immediate or significant increase in the tax base. Occasionally, there is a localized inflationary impact from increased wages, most often noticed in housing and food prices--commodities that all must purchase in one form or another. The available data shows, however, that the positive impacts associated with the Strawberry Project construction phase outweighed any negative impacts. For instance, since much of the employment was filled by local people there should not have been a significant increase in the demand for housing, etc. Furthermore, since the lands had essentially

been settled prior to the Project, the social costs often associated with large-scale population movements would not have occurred in this instance.

Second, the value of land and crop or livestock production should increase as a result of the Project. Such was certainly the case with the Strawberry Valley Project. Land values increased directly as a result of the Project, from $10 to $40 per acre prior to the Project, to $400 to $500 per acre once the lands were improved and water was available. Of course, not all of the increase can be attributed directly to the existence of water, but the presence of water certainly facilitated other improvements. In this case, there is strong evidence that water development was a necessary prerequisite to further development. In real terms, the average value of crops produced on an acre of land under the project has consistently exceeded $50 per acre. Aggregated crop values have exceeded $1,000,000 annually in real terms. Gross agricultural returns have reached as high as $18,000,000 in nominal terms. In fact, real crop value now approaches $2,000,000 annually. Gross values do not necessarily imply anything about the worth of the Project since there is no accounting of Project costs or net returns, but they do provide some measure of the economic significance of a Project. In relation to the increased value of the Project's crop and livestock production, it is important to recognize that the original cost of the Project was vastly understated. Given the final cost of the project, it is fortunate that other forms of revenue, i.e., grazing, power, and recreation, were able to provide some contribution toward repayment. The increased value of the agriculture probably could not have paid for the Project. It took 60 years to repay construction costs even with these additional sources of revenue, and continuous restructuring of repayment schedules. The repayment problem occurred in spite of the fact that the conditions of the loan were noticeably concessionary.

Third, grazing leases have provided a substantial benefit to the Association in two ways. First, revenue from grazing leases has provided extra money for repayment even though range leases were often made at rates somewhat below those for private leases. Second, the Association decided early in the Project that grazing leases would be allotted on the basis of the ownership of water rights. This certainly implies a redistribution of wealth toward members of the Association, as previous lease arrangements were offered on a competitive basis to the general public. Since the Project was also subsidized by the general taxpayer, any additional benefits accruing to the Project participants served to further redistribute wealth toward those participants. The grazing leases did allow a capture of additional benefits associated with the Project, however, which seems quite important given that agricultural production was expected to carry the major share of the repayment burden anyway. Within the Association, there might have been a resultant redistribution of wealth away from those who did not own or raise livestock toward those who did. The Bureau might have taken a more direct approach in

preventing undesirable changes in relative wealth or income positions when planning the Project. It is unclear if the current problem with the Bureau's purchase of a "fair" value of grazing rights back from the Association could have been avoided by a different pricing or leasing policy.

Fourth, power production has provided a significant contribution in the payoff of the Project. The Strawberry Project marked the first time that power was used as an income producing entity and one that made a direct contribution toward Project repayment. Power also provided an infrastructure that greatly enhanced future development as evidenced by the siting and operation of numerous agricultural processing facilities, using Project power. The Association itself evolved into a power broker. Earnings from the generation and distribution of power currently constitute the major income component for the Association.

Fifth, another benefit initially overlooked was that of recreation. While fishing is the primary interest in Strawberry as a recreation site, a number of visitor days are spent just sightseeing or hunting in the area surrounding the reservoir. Gross expenditures made by recreation participants could very well exceed $2,000,000 annually. Recreation has also caused management problems, however, at the Reservoir. There has been a history of sanitation problems associated with the Project. The problems appear to be based on the Association's administrative approach. These sanitation problems have resulted in considerable social cost to area residents and public officials, not to mention the participants themselves. Some concern has also been expressed regarding the general administration of the Reservoir as a recreation facility.

Sixth, secondary impacts associated with the Project have been substantial. A somewhat conservative estimate of the total gross Project impacts has exceeded $2,000,000 annually (in real terms) since the completion of the Project.

In summary, as early as 1915, the annual gross returns from agriculture could have exceeded $2,000,000. In real terms, the Project did reach that level throughout much of its history. On the basis of 5 percent of the gross annual income, money accruing directly to the Project (i.e., that required to pay for the Project) would exceed $100,000 per year in real terms. The present value (in 1915) dollars of that income alone, using a discount rate of 4 percent over a life of 60 years, is approximately $2,400,000. The present value (in 1915 dollars) of other annual revenue sources on an average basis, such as those received from grazing, power, etc., would have been approximately $1,300,000. Just the direct or primary benefits of $3,700,000 appear to have been sufficient to have justified the Project, since in this example a real interest rate of 4 percent was assumed while the project actually required none. As noted previously, it is reasonable to assume that the real gross secondary benefits exceeded $2,000,000 annually. It is impossible to identify that portion of the gross secondary benefits that

might be considered "net" and attributed directly to the value of the Project.

In nominal terms, the direct or primary net benefits are even more significant. Given that agriculture's normal net rate of return is approximately 3 percent, accumulative net returns from agriculture since 1976 exceeded $2,000,000. Over that same time interval, net revenue to the Association from grazing, power and recreation exceeded $1,500,000. Gross secondary benefits over this same time interval very well could surpass $120,000,000.

In addition to the annual net revenues, the value of land increased substantially once water became available on a full-service basis. In 1915, first class bench or bottom land, fully improved with a good water right sold for $150 to $225 per acre. By 1918, the value of land had increased to $400 to $425 per acre. In 1915, first class benchland, partly improved with a flood water right, could be purchased for from $50 to $75 per acre. Once water became available on a full-service basis, the value of that land also increased to $400 to $425 per acre, a five-fold increase! In 1981-82, improved, irrigated land in the Project area essentially unaffected by urban pressures sold for from $2,500 to $3,000 per acre. While not all of that value can directly be attributed to the Project, the price differential between improved, irrigated land and dry, unimproved land is still substantial, with the latter selling for $500 to $1,000 per acre. Certainly, much of the value of the Project has been capitalized into the value of the fixed asset, land, and has dramatically improved the wealth position of the land owners within the Project area.

Finally, tax revenues from the populace living within the Project area, as estimated by Larson, exceeded $2,000,000 in 1954 (Larson 1955). Even if only 25 percent of those people are directly assisted by the Project, the annual tax revenue to both State and Federal agencies could exceed $500,000 per year in real terms. It is fairly obvious that the tax benefits have exceeded the Project cost many times over. This is, perhaps, the best evidence that the Project has been financially and economically feasible.

It appears that, at least in some respects, the Strawberry Project resulted as much from business and political enthusiasm as from careful benefit/cost analysis. There is little doubt but that the benefits of the Project have exceeded the costs of the Project, although it is equally certain that the Project was paid for only with great difficulty. While area residents have certainly benefited from the Project and related developments, a question remains regarding the distribution of wealth required to achieve that end. It should be clear that a simple accounting of construction costs and production revenues is not always sufficient to identify the economic significance of a project such as this one.

XIV. BIBLIOGRAPHY

Alexander, Thomas
1971 An Investment in Progress: Utah's First Federal Reclamation Project, The Strawberry Valley Project. Utah Historical Quarterly 39 (3).

1982 Personal Communication with Author. On file, MESA Corporation, Orem, Utah.

Andersen, Jay C., Charles W. Bonem, John H. Chapman, Jr., Hollis Price Miernyk, and Bernard Udis
1962 An Analysis of the Economy of the Upper Main Stem Subbasin of the Colorado River Drainage Basin in 1960 with Emphasis on Heavy Water-using Industries. Bureau of Economic Research, University of Colorado.

Andersen, Jay C. and Lynn W. Wilkes
1968 The Consideration of Secondary Impacts in Comprehensive Studies of the Pacific Southwest Water Resource Regions. Proceedings, Symposium on Secondary Impacts, September 25-27. Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

Arid Lands Reclamation Fund Commission
1904 First Biennial Report, 1903-04. Public Documents of the State Of Utah. Utah State Government, Salt Lake City.

Arrington, Leonard J.
1958 Great Basin Kingdom, An Economic History of the Latter-Day Saints, 1830-1900. Harvard University Press, Cambridge, Massachusetts.

Avery, Alec and David Singer
1982 Utah Water Development History Research Unit. MESA Corporation, Orem, Utah.

Babb, Cyrus
1902 Report of Surveys and Examinations of Uinta Indian Reservation. House Document 671, 57th Congress, 1st Session. Government Printing Office, Washington, D.C.

Ben-David, Shaul
1970 Effects of Water Development on Location of Water Oriented Manufacturing. In Estimation of First Round and Selected Subsequent Income Effects of Water Resource Investment, edited by George S. Tolley. U.S. Army Engineer Institute for Water Resources, Springfield, Virginia.

Bradley, Iver E.
1967 Utah Interindustry Study: An Input-Output Analysis. Utah Economic and Business Review 27 (7).

Chandler, A.E.
1906 Report on Water Rights Under the Strawberry Valley Project. In Operations in Utah, edited by George Swendsen. Strawberry Water Users Association Collection, Utah State Historical Society, Salt Lake City.

Christiansen, J. Angus
1981 Oral History. Utah State Historical Society, Salt Lake City.

Christiansen, John R.
1972 Strawberry Reservoir Cabin and Trailer Business Survey. Brigham Young University, Provo, Utah.

Church of Jesus Christ of Latter-day Saints, The
1878 Utah Stake Minutes. MS on file, The Church of Jesus Christ of Latter-day Saints Archives, Salt Lake City.

Cox, P. Thomas, Wilford Grover, and Bernard Siskin
1971 Effects of Water Resource Investment on Economic Growth. Water Resources Research VII (I):32-39.

Davis, A. P., H. N. Savage, George L. Swendsen, H. Lemmon, J.S. McBeth, J. S. Page, Jr., and Heber C. Jex
1905 Memorandum from Committee for Strawberry Valley Project. Strawberry Water Users Association Collection, Utah State Historical Society, Salt Lake City.

Deseret News
1902 Articles on State Irrigation Congress. Deseret News Publishing Company, Salt Lake City.

Dixon, Madoline C.
1974 Peteeneet Town: A History of Payson, Utah. Press Publishing Company, Provo.

Doremus, A.F.
1903 The Spanish Fork River Irrigation System. In Irrigation Investigations in Utah, edited by Elwood Mead. General Printing Office, Washington, D.C.

Ely Construction Company
1912 Final Report on Indian Creek and Trail Hollow Diversion Canals. MS on file, The Strawberry Water Users Association Collection, Utah State Historical Society, Salt Lake City.

Engberg, A. F.
1915 The Strawberry Valley Irrigation Project: Utah. The

Strawberry Valley Water Users Association, Spanish Fork, Utah.

Godfrey, E. Bruce
1965 The Secondary Benefits of Irrigation Water: An Economic Appraisal. M.S. thesis. Department of Economics, Utah State University, Logan.

Hitchcock, E. A.
1905 Strawberry Valley Project Authorization Letter to Director of U.S. Geological Survey. In Project Feasibilities and Authorizations Bureau of Reclamation. General Printing Office, Washington, D.C.

Howe, Charles W.
1968 Water and Regional Growth in the United States, 1950-1960. Southern Economic Journal XXXIV (4):477-499.

Hudson, James
1962 Irrigation Water Use in the Utah Valley, Utah. Papers of Chicago University Department of Geography 79-80.

Huff, Emma N. (ed.)
1947 Memories That Live: Utah County Centennial History. Art City Publishing Company, Springville, Utah.

Jex, Heber C.
1902 Diary. The Church of Jesus Christ of Latter-day Saints Archives, Salt Lake City.

Lanphear, F. Charles and Theodore W. Roesler
1974 Impact Analysis of Irrigated Agriculture on Nebraska's Economy, 1967-1970. Nebraska Economic and Business Report 8.

Larson, E. O.
1955 Reclamation Accomplishments: Strawberry Valley Project, Utah. Bureau of Reclamation, Region 4, Salt Lake City.

Lewis, W. Cris, Jay C. Andersen, Herbert H. Fullerton, and B. Delworth
1973 Regional Growth and Water Resource Investment. Lexington Books, D.C. Heath and Company, Lexington, Massachusetts.

Luckett, John
1890 Testimony Before the Senate Select Committee on the Irrigation of Arid Lands. Senate Document 928, 1890 Government Printing Office, Washington, D.C.

MacKay, Kathryn L.
1982 The Strawberry Valley Reclamation Project and the

Opening of the Uintah Indian Reservation. Utah Historical Quarterly 50 (1):68-89.

Mead, Elwood
1903 Irrigation Institutions. The MacMillan Company, New York.

Mercier, Lynn
1982 Summary of the 1980 Hunting and Fishing Survey. Wyoming Fish and Game, Cheyenne, Wyoming.

Monson, Craig
1977 Strawberry Planning Inventory. Western Interstate Commission for Higher Education. Denver.

Morrison, W.O., Construction Company
1913 Final Report on Indian Creek Dike, and Concrete Intake Structures for Trail Hollow and Indian Creek Canals. MS on file, The Strawberry Water Users Association Collection, Utah State Historical Society, Salt Lake City.

Newell, Frederick H.
1902 Letter to Charles D. Walcott. House Document 671, 57th Congress, 1st Session. Government Printing Office. Washington, D.C.

1905 Letter to George L. Swendsen. MS on file, The Strawberry Water Users Association Collection. Utah State Historical Society, Salt Lake City.

1906 Testimony before House Committee on Irrigation of Arid Lands. House Document 236, 59th Congress, 1st Session. Government Printing Office, Washington, D.C.

Nielsen, Darwin B.
1982 Grazing Fees for Public Lands: What's Fair? Utah Science 45 (1):1-5.

O'Neil, Floyd A.
1973 A History of the Ute Indians of Utah Until 1890. Ph.D. dissertation. Department of History, University of Utah, Salt Lake City.

Patch, O.G.
1912 Review of W.O. Morrison's Performance on Indian Creek Dike. MS on file, The Strawberry Water Users Association Collection, Utah State Historical Society, Salt Lake City.

Peterson, Charles S.
1982 Utah Agricultural History Research Unit. MESA Corporation, Orem, Utah.

Powell, John Wesley
1879 Report on the Lands of the Arid Region. Government Printing Office, Washington, D.C.

Powell. John Wesley (ed.)
1889 Tenth Annual Report, Part II--Irrigation, U.S. Geological Survey, Department of the Interior. Government Printing Office, Washington, D.C.

1890 Eleventh Annual Report, Part II--Irrigation, U.S. Geological Survey, Department of the Interior. Government Printing Office, Washington, D.C.

1891 Twelth Annual Report, Part II--Irrigation,, U.S. Geological Survey, Department of the Interior. Government Printing Office, Washington, D.C.

1892 Thirteenth Annual Report, Part III--Irrigation, U.S. Geological Survey, Department of the Interior. Government Printing Office, Washington, D.C

Pratt, Parley P.
1847 Diary. MS on file, The Church of Jesus Christ of Latter-day Saints Archives, Salt Lake City.

Reclamation Service
1903 First Annual Report. House Document 70, 57th Congress 2nd Session. Government Printing Office, Washington, D.C.

1904 Second Annual Report. House Document 44, 58th Congress 2nd Session. Government Printing Office, Washington, D.C.

1905 Third Annual Report. House Document 28, 58th Congress 3rd Session. Government Printing Office, Washington, D.C.

1906 Fourth Annual Report. House Document 86, 59th Congress 1st Session. Government Printing Office, Washington, D.C.

1920 Nineteenth Annual Report of the Reclamation Service. U.S Government Printing Office, Washington D.C.

Royer, Lawrence and Emily Dekker
1976 An Inventory of the Recreational Use of Strawberry Reservoir: 1975 Summer Season. Utah State University, Institute for the Study of Outdoor Recreation and Tourism, Logan.

Salt Lake Tribune
1902 Articles on State Irrigation Congress. Salt Lake Tribune Publishing Company, Salt Lake City.

Schink, Werner O. and Joseph C. Fitz
1980 Measuring Economic Impacts: The Application of Input-Output Analysis to California Water Resource Problems. Department of Water Resources Bulletin 210. State of California, The Resources Agency, Sacramento.

Smythe, William E.
1905 The Conquest of Arid America. The MacMillan Company, New York.

Sorensen, Steven L.
1979 Register of the Strawberry Water Users Association Collection. Utah State Historical Society, Salt Lake City.

The Spanish Fork Press
1902-1905 Articles. Spanish Fork Press Publishing Company, Spanish Fork.

Strawberry Water Users Association
1910 Comments on Report of the Board of Army Engineers. MS on file, Utah State Historical Society, Salt Lake City.

1932-71 Grazing Applications, Allotments and Reports. MS on file, Utah State Historical Society, Salt Lake City.

1906-33 Grazing Leases, Permits, Correspondence, and Misc., 1906-1933. MS on file, Utah State Historical Society, Salt Lake City.

1914-82 Power Reports and Operation. MS on file, Utah State Historical Society, Salt Lake City.

1915-50 Annual Project Crop and Livestock Reports. MS on file, Utah State Historical Society, Salt Lake City.

1970 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

1973 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

1974 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

1975 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

1976 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

1977 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

1978 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

1979 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

1980 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

1981 Report on Examination of Financial Statements and Supplemental Data. Strawberry Water Users Association, Payson.

Strawberry Valley Project

1906 Project Annual History: 1906. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1907 Project Annual History: 1907. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1908 Project Annual History: 1908. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1910 Project Annual History: 1910. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1911 Project Annual History: 1911. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1912 Project Annual History: 1912. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1913 Project Annual History: 1913. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1914 Project Annual History: 1914. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1915 Project Annual History: 1915. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1916 Project Annual History: 1916. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1917 Project Annual History: 1917. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1918 Project Annual History: 1918. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1921 Project Annual History: 1921. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1922 Project Annual History: 1922. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1923 Project Annual History: 1923. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1924 Project Annual History: 1924. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1925 Project Annual History: 1925. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1926 Project Annual History: 1926. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1927-65 Project Annual History: 1927-1965. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

1966-75 Project Annual History: 1966-1975. MS on file, Bureau of Reclamation Central Utah Projects Office, Provo.

Swendsen, George L.
1904 Letter to State Senator Henry Gardner. MS on file, Strawberry Water Users Association Collection, Utah State Historical Society, Salt Lake City.

1907 Strawberry Valley Project. Reclamation Service Fifth Annual Report. Government Printing Office, Washington, D.C.

Teele, R.P.
1903 General Discussion of Irrigation in Utah. In Irrigation Investigations in Utah, edited by Elwood Mead. Government Printing Office, Washington, D.C.

Thomas, George
1920 The Development of Institutions Under Irrigation. The MacMillan Company, New York.

Torrico-Soria, Jose Isaac
1973 Economic Analysis of Cache County, Utah: An Input-Output Approach. M.S. thesis. Department of Economics, Utah State University, Logan.

U.S. Bureau of the Census

1902 Agriculture = Part I Census Reports Volume V. U.S. Census Office, Washington, D.C.

1902 Agriculture = Part II Census Reports Volume VI. U.S. Census Office, Washington, D.C.

1913 Thirteenth Census of the United States as Taken in the Year 1910. Government Printing Office, Washington, D.C.

1914 Agriculture = Vol. V = 1909 and 1910 (U.S. Dept. of Commerce). Government Printing Office, Washington, D.C.

1916 Agriculture = Estimates of Population of the United States 1910, 11, 12, 13, 14, 15, and 16. Government Printing Office, Washington, D.C.

1922 Agriculture = Vol. II = (Part 3 = The Western States, U.S. Dept. of Commerce). Government Printing Office, Washington, D.C.

1922 Irrigation and Drainage = Vol. VII (U.S. Dept. of Commerce). Government Printing Office, Washington, D.C.

1922 Population 1920 = Vol. VII (U.S. Dept. of Commerce). Government Printing Office, Washington, D.C.

1931 Agriculture = Vol. I = Farm Acreage and Farm Values by Townships or Other Minor Civil Divisions. Government Printing Office, Washington, D.C.

1932 Agriculture = Vol. III = (Part 3 = The Western States, U.S. Dept. of Commerce). Government Printing Office, Washington, D.C.

1942 Irrigation of Agricultural Lands (U.S. Dept. of Commerce). Government Printing Office, Washington, D.C.

1942 How Reclamation Pays. Government Printing Office, Washington, D.C.

1943 Annual Report of the Commissioner (U.S. Dept. of Interior). Government Printing Office, Washington, D.C.

1946 Annual Report of the Commissioner (U.S. Dept. of Interior). Government Printing Office, Washington, D.C.

1948 Reclamation Project Data. Government Printing Office, Washington, D.C.

U.S. Bureau of Reclamation
1949 Project Feasibilities and Authorizations. Government Printing Office, Washington, D.C.

1975 Water and Land Resource Accomplishments: 1975. U.S. Government Printing Office, Washington, D.C.

1976 Water and Land Resource Accomplishments: 1976. Government Printing Office, Washington, D.C.

1977 Water and Land Resource Accomplishments: 1977. U.S. Government Printing Office, Washington, D.C.

1978 Water and Land Resource Accomplishments: 1978. U.S. Government Printing Office, Washington, D.C.

1979 Water and Land Resource Accomplishments: 1979. U.S. Government Printing Office, Washington, D.C.

1980 Water and Land Resource Accomplishments: 1980. U.S. Government Printing Office, Washington, D.C.

1981 Water and Land Resource Accomplishments: 1981. U.S. Government Printing Office, Washington, D.C.

U.S. Department of Agriculture
1904 Report of Irrigation Investigations in Utah 124. U.S. Government Printing Office, Washington D.C.

1965 Recreation Analysis of the Strawberry Reservoir Area. A joint report by U.S. Dept. of Agriculture - Forest Service, and U.S. Dept of the Interior - National Park Service. U.S. Government Printing Office, Washington D.C.

1981 Agricultural Statistics. U.S. Department of Agriculture, U.S. Government Printing Office, Washington, D.C.

U.S. Senate
1890 Report of the Special Committee on Irrigation and Reclamation of Arid Lands Vol. II - The Great Basin Region and California. Government Printing Office, Washington, D.C.

Utah State Board of Land Commissioners
1896 Report on the Uinta Indian Reservation, Minutes of The Board, December 3, 1896. MS on file, Utah State Archives SE-2403.1, Salt Lake City.

Utah State Engineer
1902 Third Biennial Report, 1901-1902. Public Documents of the State of Utah. Utah State Government, Salt Lake City.

1904 Fourth Biennial Report, 1903-04. Public Documents of the State of Utah. Utah State Government, Salt Lake City.

Vernal Express
1903 Article on Proposed Strawberry Valley Reservoir. Vernal Express Publishing Company, Vernal, Utah.

Warner, Elisha
1930 The History of Spanish Fork. The Press Publishing Company, Spanish Fork.

Warrum, Noble
1919 Utah Since Statehood. The S.J. Clarke Publishing Company, Chicago.

Wolcott, Charles
1903 Letter to Interior Secretary Hitchcock. MS on file, Strawberry Water Users Association Collection, Utah State Historical Society, Salt Lake City.